CHEMICAL ANALYSIS

OF

MINERAL WATERS, &c.

AN

EXPERIMENTAL ENQUIRY

INTO THE

Chemical Properties and Medicinal Qualities

OF THE PRINCIPAL

MINERAL WATERS

OF

BALLSTON AND SARATOGA,

IN THE STATE OF NEW-YORK.

WITH DIRECTIONS FOR THE USE OF THOSE WATERS IN THE VARIOUS DISEASES TO WHICH THEY ARE APPLICABLE; AND OBSERVATIONS ON DIET AND REGIMEN.

TO WHICH IS ADDED

AN APPENDIX,

CONTAINING

A CHEMICAL ANALYSIS OF THE LEBANON SPRING IN THE STATE OF NEW-YORK.

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Tales sunt aquæ qualis terra per quam fluunt.
Plin.

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——Behold! the glooms disclose,
I see the fountains in their infant beds;
Deep, deep I hear them labouring to get free:
I see the leaning strata ——
—— The layers then
Of mingled ores, of more retentive earths;
The gutter'd rocks, the mazy-running clefts,
That, while the rising vapour they transmit,
Restrain its motion and forbid its waste:
I see the rocky siphons stretch'd immense;
The mighty reservoirs of harden'd chalk
Or stiff compacted clay, capacious form'd:
O'erflowing thence, the congregated stores,
The crystal treasures of the liquid world,
Through the stirr'd sands a bubbling passage burst,
And welling out, around the middle steep,
Or from the bottom of the bosom'd hills
In pure effusion flow.——
But who their virtues can declare? who pierce,
With vision pure, into these secret stores
Of health, and life, and joy?

Thomson.

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SECTION I.

PREFACE.

THE reputation which the waters of Ballston and Saratoga have so deservedly acquired, render them a subject of so much interest to the public, that it is to be presumed an Enquiry into their Chemical and Medicinal Qualities, will not be unacceptable.

No person can seriously doubt that a perfect knowledge of the chemical properties of a mineral water is essential to the Physician who ventures to prescribe it. There is, perhaps, no country which abounds more with useful mineral waters than America; nor are there any which are less known, or whose real qualities have been so little attended to. The physician who is engaged in extensive practice, has no leisure for such an enquiry; and so few and inaccurate are the publications on this subject, that he knows not where to seek for information on so important a branch of his profession.

It has been frequently suggested to me that an accurate analysis of the principal mineral waters of this country would be highly interesting as well to the philosopher as to the physician. In compliance,

therefore, with the wishes of those whose partiality has thought me qualified for the task, I have commenced this undertaking by giving an analysis of the principal waters of Ballston and Saratoga. A residence of some months at those places has enabled me so to vary and repeat my experiments, that I can venture to rely on the accuracy of the statements.

For the faithfulness with which they have been performed, and the zeal with which I have prosecuted this undertaking, I can also presume to appeal to the knowledge of many gentlemen of science and learning who were visiters there at the time, and who were witnesses to the result of the investigation.

Having no other wish than to give an accurate analysis, and feeling no interest whatsoever in the comparative qualities of any one particular spring, I hope that I am the last person to be suspected either of prejudice or partiality. Such as each of them really appeared to me by experiment, so have I described them.

Before commencing the analysis of those waters, it was necessary to give some account of their natural history and topographical situation. In doing so, the mineralogy of the surrounding country has not escaped my attention as a very important branch of the subject.

For the first part of this description, having no other means to acquire information, I feel myself principally indebted to those local histories of the

state which are in the hands of many persons in this country. But for the second part, I confess I should have felt myself much at a loss, had I not availed myself of that general knowledge of mineralogy which I had been enabled to acquire as one of my most favourite studies and pursuits.

The observations, therefore, which will be found on this head, both mineralogical and geological, are drawn from an inspection of every part of the surrounding country, and from such valuable information as I could derive from the geological map of Mr. M'Clure, the only authority which I had to rely upon.

Without the aid of mineralogy, the chemical analysis alone of a mineral water would render our enquiry imperfect and unsatisfactory; in treating this subject, therefore, scientifically, I have frequently been obliged to make use of technical expressions which are not familiar to the generality of readers; for this I must claim some indulgence, hoping at the same time that, in the course of this work, useful information may be found in it by all classes of readers.

It is not within the province of a chemical writer alone, to speak of the medicinal qualities of a mineral water; but as I conceive that this work would be less extensively useful if I confined it to a mere chemical description, I have been induced as a physician to dwell at some length on the medicinal properties of these waters, the use and abuse of them.

The observations which I have made on this branch of the subject are the result of extensive experience at those watering places in Europe which have any resemblance to these, and are most esteemed.

Differing as I do in many points with the generality of those who make use of the waters of Ballston or Saratoga, I cannot flatter myself that all my opinions will be adopted even by the profession. But I still hope that some of my suggestions may be practically useful, and that they may be received with liberality and candour.

For the views of the villages of Ballston and Saratoga, taken on the spot, which accompanies this work, I feel myself indebted to the pencil of M. Lesueur, whose talents as a naturalist and a draftsman, are too well known both here and in Europe to require any eulogium of mine.

While in the neighbourhood of Lebanon in the state of New-York, I embraced that opportunity of examining the Thermal Spring which is situated there and is much frequented by invalids. I have therefore added as an appendix, the chemical analysis of this water, which I hope will not be found uninteresting, as affording a very remarkable contrast to any of the waters either of Ballston or Saratoga, having scarcely any one quality in common with them; and exhibiting, at the same time, some curious and interesting chemical facts; to which I have also added a few practical observations on the virtue of this water, both externally and internally.

The result of this experimental enquiry I now submit to the public, conscious that I have engaged in one of the most difficult investigations in chemistry. If it should be found in any degree useful, or if it should lead others to pursue so interesting a subject, I shall consider the time and labour which I have bestowed on it, as not misapplied.

DRAWN BY C. A. LESUEUR

ENGRAVED BY J. HILL

A VIEW OF BALLSTON SPRINGS TAKEN FROM ALDRIDGES HOTEL

CHEMICAL ANALYSIS

OF THE

PRINCIPAL WATERS

OF

BALLSTON AND SARATOGA.

CHAPTER I.

Description of Ballston and Saratoga—the situation and number of the Springs; with Observations connected with the Mineralogy and Geology of its vicinity, and the surrounding country.

THE village of Ballston, in which the springs are situated, lies in the county of Saratoga in the state of New York, about two hundred miles north of that city, and about twelve miles west from the Hudson or North river. It is situated in a deep valley, through which passes a branch of the Kaydarosoras river. It is surrounded by a range of undulating hills, which form a species of amphitheatre, and from which a most agreeable view of the town is presented.

The soil in the neighbourhood is poor and sandy,

covered with oak, pine, and hemlock, except in the vicinity of the town, where even the sand hills, which surround it, are almost cleared of their wood, which greatly impairs the effect of the scenery.

Within seven miles of Ballston is situated the village of Saratoga. The road from Ballston to it is chiefly over a sandy pine plane, and the face of the country around is on the whole wild and barren, except in the valleys, where the soil is more fertile and well cultivated. A range of hills or mountains run to the westward exhibiting the appearance of one vast forest, which when viewed from the heights that surround the village, present a very striking and picturesque scenery.

Before I speak particularly of the rocks in the neighbourhood of Ballston, it may not be uninteresting to trace the strata from the mouth of the Hudson or North River.

Commencing at the west side of this river near Princeton in New-Jersey, we observe the first appearance of the red sandstone, which, according to some geologists, first succeeds the transition rocks. Here commence rocks of secondary formation reposing upon the sandstone. Passing through Newark towards the North River, the beds of sandstone are very apparent. Proceeding in a westerly course towards the Pasaaic, a range of hills commences which are formed of secondary rocks still resting on the sandstone, till arriving at the falls of the Pasaaic, those rocks assume a perfect secondary character,

which is well observed at the falls where the strata is very much broken; the rocks in this place exhibit masses of trap alternating with secondary green stone, clink stone, wacke, and amygdaloid. This formation stretches to the North River, and in its course as far only as Tappan, where it terminates, and the primitive rock appears. This primitive formation is a continuation of that immense chain of primitive mountains which prevail and extend through the eastern states, and which crosses the North River between Tappan and Newburgh, running under the secondary and transition rocks at those places and taking a westerly direction.

At Newburgh on the North River the primitive is lost, and a transition country presents itself, which can be traced along the banks of that river for near one hundred miles, forming a range of hills which in many places consist of trap rocks assuming a columnar structure. Those rocks of trap, alternate with greenstone, whinstone, argillaceous schist, and grey wacce slate, till passing through Albany we arrive at the Mohawk, where the same transition rocks are again observed with little variation, particularly at the Cohos falls, where from the violence of the cataract the irruption of the rock is considerable: the transition rock is still observed at both sides of this river, but soon after a range of sandhills commence, and all traces of the strata are lost for several miles; till after having passed over those hills which extend to the distance of twenty miles, and proceeding in a

westerly course from the Hudson river, we arrive in the neighbourhood of Ballston. Here the flœtz or horizontal formation is first observed, and continues to prevail through a great extent of country, taking in the whole of Ballston and Saratoga, extending to the westward to the borders of lake Ontario and lake Erie, and terminating with an extensive range of mountains to the north-west at the distance of about thirty miles. Proceeding to the north towards lake George the secondary ends, and the primitive formation commences and continues to prevail, constituting the whole range of hills which run at the west side both of lake George and lake Champlain, while the east side of those lakes are transition.

But as the nature of the rocks which are in the immediate vicinity of Ballston and Saratoga require more particular notice, I shall confine myself on this occasion principally to their description.

The ground is principally composed of two or three species of rocks of secondary formation, but these are so covered with immense beds of sand, that it is difficult to ascertain this formation, and it can only be done by an attentive examination of the rivulets which in some places have laid bare the strata.

The surface of the ground both at Ballston and Saratoga is covered with large insulated masses of stone, commonly called boulders, consisting of large blocks of quartz and rolled masses of other primitive rocks. These scattered blocks must have been trans-

mitted from the neighbouring mountains, as they are not attached to the rocks in situ, and have no connexion with them; they are found in every country and only prove the action of an extensive flood of water. We are not therefore to consider them as comprising any part of the rocks of this place, as has been the case with those who have inattentively examined its mineralogy; in this way only can I account for the statement which has been given by Professor Griscom, when he says, that "at Saratoga are many rocks in hardness approaching to porphyry, nor are calcarious or magnesian stones found in the neighbourhood of the springs."* This assertion is certainly a mistake, as the whole of the rocks in the neighbourhood are principally calcarious, nor can either granite or porphyry be observed in any direction, except in these insulated masses which are extensively scattered over this part of the country.

In the centre of the village of Ballston an excellent opportunity is offered of examining the situation of the strata. A small rivulet runs through it, which has laid bare an entire range of flœtz or horizontal rocks, consisting of what may be called a calcario-argillaceous schist or shale. This schist is nearly of a black colour, and from its staining the fingers would appear to contain a portion of carbon; it effervesces slightly with acids, which shows that it also contains carbonat of lime; it breaks easily into

* Vide Bruce's Mineralogical Journal.

laminæ of any thickness, and impressions of vegetables, chiefly of a species of grass, can be observed between the laminæ; but when large masses are exposed for any length of time to the atmosphere, it rapidly shivers, or decomposes; and at this time assumes a trapezoidal form, having a tendency to break into spherical masses or columns of a prismatic shape, which are principally either hexagonal or pentagonal. Specimens of this schist I have deposited in the cabinet of the Philosophical Society of Philadelphia, where this change of fracture which is singular can be noticed, such as is frequently observed by the sudden congelation or drying of large parcels of starch.

Alternating with this schist and near the same place, wherever the beds of sand will admit an inspection of the rock, solid masses of calcarious rocks are observed, particularly within three miles of Ballston, where a mill site has been erected, and where the flœtz or horizontal formation of the rock is most beautifully illustrated. This limestone is nearly of a black colour, its fracture is slaty, it abounds with shells of various forms, some of which are so very apparent in their structure and form as not to be mistaken; they principally consist of bivalves, maddrapori, terebratulites, corrolites, and echinites, so extremely similar in many respects to fossils which I have in my possession from Mendip in England, that it is difficult to distinguish the specimens from each other. This stone when rubbed emits an urinous

smell similar to the stink stone of Werner; it burns also into lime, when it loses its colour. On the whole, I think that this may be called the third or newest flœtz lime stone of geologists.

When we arrive at Saratoga the same species of rock presents itself, and is so apparent, particularly in the neighbourhood of the springs, that it is only surprising how it should have escaped the notice of the most superficial observer. But there is some variety here in the formation of the rocks; the shells are not so abundant in it, and the greater proportion of the rock is traversed with seams of flint or chert which is found embedded in it, sometimes in the form of veins, but principally in nodules or rolled pieces, so intimately mixed with the limestone, that they appear to run into each other, having no simple line of division between the calcarious and siliceous parts; the former being penetrated with particles of the latter, which is a much more remarkable fact than finding seams or nodules of siliceous matter in a stratum that is purely calcarious, and would seem to strengthen the opinion of those who conceive that lime and flint are convertible into each other by natural processes.

Specimens of this peculiar rock I have also deposited in the cabinet of the Philosophical Society, as it is only by collecting and observing such facts, that we can ever arrive at any correct geological knowledge.

Besides these rocks which I have attempted to

describe and which characterize a secondary country, it is necessary to state that those undulating hills which surround the village of Ballston, and which continue to prevail in the village of Saratoga, are formed principally of immense beds of fine siliceous sand, as may be particularly observed in the rear of Alldridge's boarding-house, where the height of one of those hills, which is very precipitous, cannot be less than 150 feet; under this sand lies immense beds of stiff blue clay, which hardens when left for any time exposed to the atmosphere; it effervesces slightly but does not dissolve in acids, from which I should rather call it an argillaceous marle; it appears with some probability to have been formed by the decomposition of the schist in the neighbourhood; it is to be found by digging in the valleys in any direction, and it can be well observed on the side of a declivity near *Lowe's Well*, where a considerable saline efflorescence can be seen on its surface, particularly after rain, owing to the chrystallization of the salt which is produced by the sun's rays. This is a very interesting fact, and as exactly such a peculiar species of clay is found to prevail in the soil from which the waters of Cheltenham arise, it may tend in some degree to explain from whence waters of this description receive their saline impregnation. Indeed every circumstance connected with the geology of this part of the country indicates something of an alluvial deposition, and can leave no doubt in our

mind of the very great influence which an extensive deluge has had in its formation.

No metallic veins of ore have been discovered in this neighbourhood in any direction, nor indeed were they to be expected, as the strata which I have described is never accompanied with any valuable minerals, and except iron, which is found in all the low grounds in the state of an argillaceous or bog iron ore, I know of no other metallic deposit.

Many circumstances induce me to suspect that coal may be found in this neighbourhood, though as yet no trace of it has been discovered on the surface of the ground; yet as it is usually found in the same formation and almost always accompanies that peculiar species of shale which is observed here, it is not improbable but this may be found the seat of an extensive coal deposit.

Having thus given a sketch of the mineral strata which exist in the vicinity of Ballston and Saratoga, and of the surrounding country, I cannot here help noticing the term *New World*, which is frequently applied to this continent, as if there was something in its formation and origin which was of later date than that of Europe.

The observations, however, of every traveller would refute this opinion, and place the origin and structure of this part of the world much anterior to the greater part of Europe. Had Linnæus visited this country and examined its vast and beautiful variety of plants, some of which now adorn the gardens and

shrubberies of modern Europe, he would not have called this a New World. Had Werner, when forming his theory of the earth, visited the rocks of this country, its great mountain ranges, where almost all is primitive and on a stupendous scale, and had he compared these with such as he had previously seen, he would not be inclined to call this a New World. Had Cuvier, after examining the organic remains of the vicinity of Paris, visited and explored the banks of the Mississippi and Ohio, and traced there the remains of the most gigantic animals of the creation, he would have hesitated before he pronounced this a New World. If, however, by new world is meant nothing more than that many of its productions are new to the European; that the institutions of the inhabitants are new; and that the state of the arts and sciences are comparatively new, then I confess there is no great misapplication of the term.

I now come to give a more particular history of the situation of the springs which are found at Ballston and Saratoga.

It is usual to commence with giving some account of the circumstances attending the first discovery of any particular mineral water. On this subject, however, in a part of the country which has scarcely been settled a century, it is difficult to obtain any accurate information; from which cause we cannot even have any very remote tradition. But if we cannot trace the use of these waters to so early a period as the eleventh century, as has been the case with respect

to the waters of Pyrmont; or if we cannot show that the Emperor Charlemagne enjoyed the benefit of them in the same manner as he is said to have done at those of Aix la Chapelle, still we may venture to presume that the native princes, or chiefs, of this country, were not unacquainted with their qualities, and partook of the use of them at full as early a period; indeed every enquiry seems to confirm the opinion which the present inhabitants entertain, that those mineral waters were first pointed out to their ancestors by the original inhabitants of the country; nor is this by any means improbable when we reflect that those people who draw all their remedies from the obvious qualities of those plants which nature presented to them, if furnished with no other criterion but taste, could scarcely overlook the striking effect which was produced by the use of a water which differed so much from that which they were generally accustomed to drink. Its qualities therefore must have early attracted their notice, and thus it is not difficult to understand from what source the first European settlers derived their information: however this may be, the qualities of these waters were early known to the present inhabitants, and it appears were used medicinally by them, with uncommon success, till by degrees their reputation increasing, persons resorted from a distance to this place for the use of the waters, and thus villages sprung up in situations which had nothing particular to recommend them but the advantages which they derived

from springs possessing such powerful medicinal qualities.

At this period there are few places in any country where the invalid, or the man of leisure, can be more agreeably accommodated than at Ballston and Saratoga. In this, certainly Ballston first took the lead, principally owing to the spirited exertions of a wealthy proprietor, who has spared no expense in erecting a building at once spacious and commodious; and this, with several other hotels equally respectable, has established Ballston as a watering place of the most fashionable resort in the United States.

While Ballston was thus increasing in reputation, the springs of Saratoga were rising fast into notice. Their numbers and variety could not escape attention; and it was soon perceived that one of them in particular, called the Congress Spring, possessed superior strength to any of those at Ballston; and that in many instances it was found to exhibit powerful medicinal qualities. Visiters, therefore, to Saratoga, yearly increased; and the erection of handsome buildings for their accommodation was the natural consequence; so that it is now difficult to say which of those places afford the most comfort and convenience to those who frequent them. That nothing should be wanting at either of those places, warm baths are provided for the benefit of those who require them, the use and abuses of which, as well as of the waters themselves, I shall hereafter discuss.

At such places as these, there is but one method of living, to which all persons must submit; it has, however, this advantage, that it contributes to social intercourse and amusement, but seldom to dissipation. At all those public tables which afford accommodation to the company, the utmost regularity and order is observed; regular hours, wholesome and excellent provisions, attended with a proper degree of abstemiousness and sobriety, contribute to restore the health, and to assist the medicinal qualities of the waters.

The season of the year which is judiciously selected for the use of these waters, is the summer months, at which time some of the large cities are deserted by many of their inhabitants from the supposed insalubrity of the air in them; thus adopting the advice of a favourite poet, who describes such places in the following lines:

Ye who amid the fev'rish world would wear
A body free of pain, of cares a mind;
Fly the rank city, shun its turbid air;
Breathe not the chaos of eternal smoke
And volatile corruption, from the dead,
The dying, sick'ning, and the living world
Exhaled, to sully heaven's transparent dome
With dim mortality.
While yet you breathe, away; the rural wilds
Invite; the mountains call you, and the vales;
The woods, the streams, and each ambrosial breeze
That fans the ever undulating sky.

ARMSTRONG ON HEALTH.

Great benefit is found by this change, as the climate is much cooler in summer at Ballston and Saratoga, than in the neighbourhood of any of the large cities. The thermometer seldom rises so high, and the nights are always cool and comfortable. On the whole, the country around it is perfectly healthy except in the vicinity of some of the lakes, where late in the autumn occasional intermittents are found prevalent, but this was the case more frequently formerly than at present, and will continue to decrease as the woods are cut down and the land becomes drained. On the whole, so few instances of these intermittents have come under my observation, that I consider them as very rare indeed, and no cause of alarm to the visiters either at Ballston or Saratoga, as from their situation and the nature of the soil in their vicinity, which is dry and sandy, nothing of the kind can be apprehended in those places.

There are only two springs in general use at Ballston; one of them (that which was first discovered) is situated in the centre of the town, and is called the Public Well, having been reserved for the benevolent purpose of serving the public by Sir William Johnson, in the original grant of the land to private individuals. This spring issues from a bed of stiff blue clay and gravel which lies near a stratum of schist or shale, nearly on a level with the brook or rivulet which runs through the town, the course of which rivulet has been changed by a dyke or canal, in order to divert it from the source of the springs.

The ground rises with a gentle acclivity to the north of the Spring, forming one of those sand hills which have been already described.

The Well is five or six feet deep, and the water rises up in such abundance, that it would be difficult to ascertain the quantity which it pours out in a given period of time. Immense quantities of gas in the form of air bubbles, break with a sort of explosion on the surface; and whenever the water continues at rest for any time exposed to the atmosphere, a slight irridescent pellicle appears on its surface.

A circular vessel of wood forms the Well in its present state, into the side of which a trough is introduced which carries off the redundant water. The sides of the vessel which is here introduced to confine the water are covered with an incrustation of a light brown colour, and the whole channel, through which the water flows, contains such a quantity of this substance, which is constantly depositing, that it is necessary to remove it every year, in order to give a free passage to the waters of the well.

This deposition is erroneously supposed to be the iron which is deposited from the water; but this is not the case, as the analysis will hereafter show. It effervesces and nearly dissolves in acids, which proves that it consists principally of earthy carbonates coloured by oxyd of iron.

For what reason I know not, the ground has been

raised to the height of six or seven feet round the well, so that the water is taken up in a glass tumbler attached to the end of a long iron rod. Whether this is the most judicious mode of constructing the well, is worth serious consideration;—it certainly is not the most convenient, nor does it seem judicious to surround the water with wood when cisterns of marble or sand stone could be so easily obtained.

By a proper construction of the well, and surrounding it with marble, any communication with the water of the hill may not only be effectually prevented, but the spring may by this means be made to rise much higher, so as nearly to find its own level. This would improve the qualities of the water, as from the additional weight and pressure, as well as from a greater surface of the water being exposed to the gas which is extricated from the bottom of the spring, a much larger quantity of it would be absorbed.

But as this fountain is so precious in the opinion of the inhabitants of the place, all suggestions of this kind are received with great suspicion and alarm, lest it should make any alteration injurious to the character of the water.

The next well is situated about 200 yards to the west of the public one. It lies very low in the valley and not many feet above the level of the rivulet. The soil from which the water rises is much the same as that of the public well, but close to the spring is a peat morass several feet deep, which is

annually accumulating and will continue to do so till it is drained.

This spring, which is called *Lowe's Well*, from its being situated on the private property of that gentleman, shows exactly the same appearance as the public well, which I have just described; its taste and obvious qualities are so precisely similar that I found it impossible to distinguish between them; it is also confined in the same manner by means of a circular vessel of wood, which has an opening to admit the passage of the water after it rises to a certain height. The ground around it is not so high, so that it is easier of access, and has the advantage of being covered with a building which is connected with the warm baths.

By digging in the neighbourhood of this well in almost every direction, springs will be found exhibiting the same qualities in a slight degree; some of them are visible at present, impregnated with iron and saline particles, but by no means so strong as the water of Lowe's spring, which, with the public well already mentioned, are the principal ones which are generally and indiscriminately used.

Within about thirty yards of Lowe's well, the analysis of which I have given in a particular manner, another spring something similar to this is to be seen, but by no means so strong in its saline contents. It however differs in some respects, as it exhales in a slight degree the peculiar vapour of sul-

phurated hydrogen gas, in consequence of which it is supposed by some to possess the properties which are usually attributed to sulphurous waters. Having examined it with proper tests, I did not find it of consequence sufficient to make an analysis of it.

Some persons who have visited these springs many years ago, have pretended to remark, that these waters are not so highly acidulous and sparkling at present as they formerly were; but I have no doubt that this is a mistake. If we judge from analogy, we have no reason to suspect it. We know that some of the most celebrated mineral waters in Europe have uniformly preserved for centuries not only their temperature, but the same physical properties. What reason, therefore, can we have to imagine, that those waters in particular should suffer any alteration: it would be less surprising to find that they had totally disappeared, from accidental or natural causes, than to suspect any diminution of their qualities, while they flow in the same place, and in the same manner. Taste alone, therefore, cannot be relied upon; and as there is no criterion of heat to be depended on but the thermometer, so can there be no true criterion of the real qualities of any water but by chemical analysis.

Much of what I have here said will apply to the springs at Saratoga; however, they are too important not to speak of them separately and distinctly.

The situation of the country round Saratoga differs but little from that of Ballston, except that the hills are not so high, and the valley is more extensive. It lies low, and the soil is principally sand or gravel, covered with peat. In this valley a number of springs are to be found, showing more or less the same sensible qualities. To these wells, different names are given, such as the Congress Spring, the Flat Rock, the Hamilton, the President, the Columbian, the Round Rock, &c. They are but a short distance from each other; and as the same appearances present themselves in every part of this valley, many more may certainly be found if it was examined.

The water in each of those springs arises from a bed of sand intermixed with stiff blue clay, and overlaying the calcarious and schistose rocks.

The source of these springs does not appear to lie deep, as they are all found within five or six feet of the surface.

They are all confined or enclosed in circular or square wooden vessels, not more than five or six feet deep.

In all of these wells, the same sparkling appearance and extrication of gas is observed, as has been already described, but in some rather more than in others, which seems in some degree to depend on the shape and extent of the well. Some of those springs rise nearly to the surface; others, such as the

Congress Spring, is not raised to within four or five feet of it, and the water is dipped out with a glass in the same manner as at Ballston.

The waters flow from this well in particular in great abundance, affording not only sufficient for the daily use of the company, but allowing immense quantities of it to be carried off not only in bottles but in barrels, for the use of those at a distance, without any sensible diminution either of its quantity or quality.

One of these springs, called the Round Rock, has something so peculiar in appearance as to attract particular notice. It is situated at the foot of a calcarious rock low in the valley, and is covered by a cone or pyramid near six feet high; this cone is hollow and has a hole at the top about nine inches wide, from which the water can be seen in a state of agitation, as if boiling, from the extrication of gas, which rises to the surface. An opening, at the bottom of this cone, about four or five inches wide, on a level with the surface of the ground, gives an exit at present to the water. I say at present, for the whole of this curious formation admits of an easy explanation. This, as well as all those springs, contain a large portion of lime held in solution by the excess of carbonic acid which they contain. When exposed to the atmosphere the carbonic acid flies off, and the lime is precipitatd in the form of a stalactite or calc tufa; at the first appearance of this water on the surface,

this process took place at the edges and sides of the well, till in the progress of time the whole of this cone, consisting of carbonate of lime, was formed, the well always rising as it was confined, and continuing to flow or find its own level at the top; till either from accident or design an opening was made at the bottom of the cone, which now gives an exit to the water, and spoils the appearance of this natural bason, requiring nothing more to restore it to its former situation than carefully to close the opening at the bottom, when the water as before would rise to meet its own level.

As all those springs show more or less the same sensible qualities, and as is was too arduous an undertaking to make a chemical analysis of each, I chose out two which seemed to be most generally preferred, and whose obvious qualities were the most remarkable; these are the Congress Spring and the Flat Rock: indeed with respect to the Congress Spring there seems to be no difference of opinion, its taste and physical qualities are sufficient to distinguish it. I have therefore bestowed particular attention to its analysis, from a comparison of which with the waters of Ballston, important inferences with respect to their medical qualities shall be drawn hereafter.

I shall first commence with the analysis of *Lowe's Well* at Ballston; from this I shall proceed to the analysis of the Public Well at the same place, which

will be followed by observations on their comparative contents.

To this will succeed a particular analysis of the Congress Spring at Saratoga, as well as of the Flat Rock, drawing such inferences from this analysis as will explain the particular qualities of each.

CHAPTER II.

Chemical Analysis of Lowe's Well at Ballston—External Qualities of the Water—Temperature and Specific Gravity.

This water at the spring is constantly emitting a large quantity of gas which arises from the bottom of the well, and passing in bubbles through it, break on the surface. This gas proves fatal to animal life. Birds or fishes, if suspended over it for a few minutes, are immediately killed.

The temperature of the water is uniformly 52° of Fahrenheit; I never perceived the smallest variation when the thermometer in the open air was at 90°; and I am informed that during the coldest weather in winter, its temperature is invariably the same, for which reason at this season a thick steam is perceived over the well.

I took considerable pains to ascertain its specific gravity by a variety of methods, and after repeated trials with the most accurate hydrometer, I found it to be to that of distilled water as 1008 to 1000, the temperature of both being 60 degrees.

This also coincided with experiments made with a phial bottle, calculated to hold exactly 1000 grains of distilled water when the glass stopper, which was finely ground, was fastened in it. Repeated trials

with a most accurate balance, the water being at the temperature of 60°, gave the specific gravity of Lowe's Well precisely as before—1008; and it will be seen when I come to describe the waters of Saratoga, how useful this method of examining a water may be to the chemist, as the proportion of saline ingredients may, in some measure, be estimated by its specific gravity.

When this water is first taken from the well in a glass, it is perfectly clear and transparent. It emits a number of air bubbles, and sparkles a little when poured from one glass into another. If let remain in the glass for a few minutes, the gas which is extricated from it, especially in hot weather, adheres in the form of innumerable air bubbles to the inside surface of the glass. If the water is let stand for some time in a glass vessel, these air bubbles continue to increase in quantity; in a few minutes the water loses its transparency, a slight pellicle appears first on its surface which has somewhat of an irridescent appearance, by degrees the water becomes perfectly opaque, the pellicle falls to the bottom, which, as well as the sides of the glass, is coated with a light brown powder, which adheres firmly to the glass. The water then by degrees recovers its former transparency, but has totally lost its agreeable pungent taste; it is now perfectly vapid, and has no other taste but that of a solution of salt in water.

When a glass of the water is just taken from the well, it has a saline and pungent taste, with an evi-

dent chalybeate quality which is far from disagreeable; on the contrary, though so highly saline, those who are accustomed to it, drink it as a most agreeable beverage. The pungency of it is so great as to affect the palate somewhat like bottled liquor, and the first effect of it on the system is to produce a slight giddiness, and a certain degree of exhilaration of spirits. These qualities of it have not escaped the notice of those who reside in its neighbourhood, and have fortunately sufficient attractions to supersede in some degree the baneful use of spirituous liquors. In corroboration of this, I was assured by a high military character,* that when part of the American army was quartered in the district during the revolutionary war, the soldiers became so attached to this water, that during their stay a much less quantity of spirits was drank by the men, and that fewer instances of drunkenness came to the knowledge of their officers.

But these effects, which render the waters so agreeable, soon disappear, and are not peculiar to this spring, as all waters highly impregnated with carbonic acid gas have more or less the same qualities, followed by other symptoms of a very different nature, according to the quantity and quality of those substances with which they are impregnated.

* General Humphreys.

The celebrated Dr. Hoffman, whose experience on this subject has been extremely extensive, when speaking of the carburated chalybeates of Lauchstadt in Germany, describes their effects in the following words:

" Non raro contigit, ut aqua nostra primùm maximè ab insuetis pota, nauseam, vomitum, inflationes, dolores circa præcordia, *capitis graviditatem*, *somnolentiam* . . . suscitat: sed . . . . continuato usu, et pervadente aquâ, omnia spontè evanescunt."

These few lines which I have quoted give so accurate a description of the first effects of such waters on the system, that I feel no necessity of adding to it.

Examination of the Contents of the Water by tests or reagents.

Experiment I.

Litmus Paper when dipped into the water of the well at the fountain, has its colour immediately changed to red, but this colour is fugacious; nor will the water when boiled produce any such effect, a decisive proof that this change was produced by the presence of a large quantity of uncombined carbonic acid, and not by a fixed acid.

Experiment II.

Paper stained with Turmeric is not changed in colour by this water when fresh from the spring, nor could it be expected, for though we shall find hereafter earthy carbonats, yet they are suspended by such an excess of carbonic acid as to repress the effect of this test.

Experiment III.

Lime Water produces an immediate turbidness and a precipitation when added to this water, yet a variety of circumstances are here to be attended to. This water contains such a quantity of carbonic acid gas, that if it is added in too large a quantity, the lime which is at first precipitated, is almost immediately redissolved by the excess of carbonic acid. The

directions which are usually given are, that the lime water should be added in equal quantity; this is here, however, too great a proportion; the first effect is certainly a white cloud, but it is immediately redissolved, and the solution, as long as the bottle remains closed, continues clear.

In order to insure a complete and permanent precipitation of the lime water, one part of this mineral water to three parts of lime water is sufficient. A tolerable accurate estimate may be made in this manner of the quantity of carbonic acid in a mineral water.

I do not know that this circumstance has been before attended to, but it is evident from the above experiment, that the greater the quantity of carbonic acid gas which is contained in a mineral water, the less of that water is required to decompose a given quantity of lime water. Thus, waters containing little carbonic acid require to be added in the proportion of three parts to one; but water containing its own bulk of carbonic acid, (as we shall find that this does) requires only to be added in the proportion of one part to three of lime water, in order to produce the same effect; so that this observation cannot be without its use in forming a judgment of the quantity of carbonic acid gas which is contained in a mineral water.

Another method has been proposed by Dr. Pearson, by Gioanetti, and others; and Dr. Garnett, in his able Analysis of Harrowgate Waters, has applied

it to this purpose, by weighing the precipitate, calculating the quantity of carbonic acid in each grain of lime, and comparing this with the weight of a cubic inch of carbonic acid gas; however, this requires so minute a calculation that it is difficult to apply it with advantage, even if it was not liable to the very serious objection of want of accuracy from the circumstance of lime water being precipitated by other gases as well as by alkaline salts, which are not unfrequently found in mineral waters.

EXPERIMENT IV.

Tincture of Galls, when poured into this water, strikes an immediate purple colour, which after standing for a short time increases in intensity, and a precipitate, nearly black, falls to the bottom of the glass.

EXPERIMENT V.

Prussiat of Potash, a few drops of this poured into a glass of the water fresh drawn from the spring, changes it immediately to a green colour, which gradually becomes blue; and on standing for some hours, deposits a light blue sediment; neither this, or the former test, produce any change after the water has been boiled and filtered, or even exposed for some hours to the atmosphere. The prussiat which I used on this occasion was prepared by Vauquelin, and had been previously crystallized. A variety of circumstances, however, satisfied me that this water

contained more iron than this test indicated; I suspected that the quantity of alkaline earths which it contained repressed the effect of it: a few drops of muriatic acid were therefore previously thrown into a glass of the water; this combining with the carbonats, produced an immediate effervescence; when those were saturated, the prussiat of potash was applied; a very sensible difference both in the colour and quantity of the precipitate then took place; a very dense blue cloud being immediately produced.

It is necessary, however, to be certain that the marine acid is perfectly pure, as it is extremely difficult to procure it free from iron. This can easily be ascertained by previously dropping into it a little of the prussiat of potash.

These tests decide the presence of a considerable quantity of iron in this water, and also show that it is held in solution entirely by the carbonic acid.

A person who has much experience on this subject, and has been in the habit of making those experiments, can judge with some degree of correctness of the quantity of iron which is held in solution in a mineral water, as well by the intensity of the colour, which is produced by prussiat of potash, as by the quantity of the precipitate.

Experiment VI.

Solution of Acetat of Lead, when dipped into this water, produces an immediate white cloud and a pre-

cipitation at the bottom of the glass. This may have arisen from sulphuric or marine acid, or from alkaline earths or salts combined with carbonic acid; however, it is not difficult to determine which of these substances were the cause of the precipitation. This was first by saturating those alkalies with a little nitric acid, still the same precipitation took place; it was then evident that the precipitation was occasioned either by the sulphuric or marine acid or by both; to decide this, I collected the precipitate and found it was wholly soluble in distilled vinegar. It therefore was not sulphuric acid, as sulphat of lead is entirely insoluble in distilled vinegar, while muriat of lead is totally soluble in this menstruum. It must of course have been occasioned by marine acid, which, we shall find by the following experiment, is present in large quantity in a state of combination.

EXPERIMENT VII.

Solution of Silver in Nitric Acid. When a few drops of this solution is poured into a glass of the water, an immediate white and ponderous precipitate falls down to the bottom of the glass, which after standing some hours changes to a light brown colour. This dark colour is certainly owing to a very small quantity of sulphurated hydrogen gas, of which this change of colour is one of the nicest tests, yet so minute as not to be collected in a separate state, but still frequently sensible to the smell; however as the

vapour of vegetable decayed matter, dissolved in water according to Klaproth, is apt to give a deceptive indication of sulphurated hydrogen, I am disposed to attribute it to this, particularly as the situation of the spring is such, in the vicinity of a peat morass, that it may receive its impregnation from it. The precipitate, however, occasioned by the nitrate of silver, which is very abundant both before and after the water has been boiled, is undoubtedly owing to a large quantity of marine acid in a state of combination.

EXPERIMENT VIII.

Nitrat of Mercury, immediately produces a white cloud and precipitate when poured into the water. This test is an additional proof of the presence of marine acid, and it is said by Plaff to be even a nicer test than nitrat of silver, though as it is precipitated by other substances, it should not alone be relied upon.

EXPERIMENT IX.

Muriat of Barytes, produces no change in the appearance of the water when first taken from the spring, nor after it has been boiled for some time, and by this means deprived of its carbonic acid and earthy carbonats; neither has nitrat of barytes or muriat of strontian the slightest effect on the water. These are decisive proofs that it contains no salts combined with sulphuric acid, a circumstance ex-

tremely uncommon, as few even of the common well waters in any country are free from gypsum or sulphuric acid in some state of combination.

EXPERIMENT X.

Oxalat of Ammonia produces an immediate cloud and precipitate in this water when fresh taken from the spring, and has the same effect, though in a very slight degree, when applied after the water has been boiled for some time; this shows that carbonat of lime is held in solution partly by the carbonic acid and partly by a mineral acid.

EXPERIMENT XI.

Sulphuric Acid. When a few drops of this acid are poured into a glass of the water, an immediate and brisk effervescence takes place, from the extrication of carbonic acid gas; in a short time the colour of the water is changed, and after standing for an hour a white powder is deposited on the bottom and sides of the glass; this powder was evidently sulphat of lime, as nitric and muriatic acid produce the same effervescence and extrication of gas, but no deposition takes place nor is the transparency of the water changed, these acids forming soluble salts with the earths which are contained in this water.

EXPERIMENT XII.

Carbonat of Ammonia, produces no effect when added to the water fresh from the spring.

EXPERIMENT XIII.

Carbonat of Potash, does not disturb the transparency of the water.

EXPERIMENT XIV.

Pure Ammonia, causes an immediate cloud in the water when added to it fresh from the spring, and a copious flocculent precipitation takes place; this it does by taking up the excess of carbonic acid which holds the earths suspended, and becoming itself carbonated; but when a mild alkali is employed, no such effect is produced, as has been seen in the previous experiment.

Pure Potash has precisely the same effect, and for the same reason; but when a few drops more of potash are added and the glass stirred, the white cloud disappears and the precipitate is redissolved, for the same reason that calcarious earth is dissolved in lime water; in this case an excess of pure potash deprives the lime of its carbonic acid, and therefore it becomes soluble again.

These were the principal reagents with which I commenced my enquiry. Superfluous trials were unnecessary, and heaping experiments upon experiments, without any apparent design, tends only to perplex rather than to convince upon any rational grounds.

It was now necessary to make a few experiments on the water after it had been boiled. I therefore

boiled down three pints of the water till it was reduced one third, and till the iron and earths which were suspended by carbonic acid were wholly precipitated.

The following tests were then made use of.

EXPERIMENT XV.

Sulphuric Acid now neither produces any effervescence nor is there any precipitation.

EXPERIMENT XVI.

Paper stained with litmus is not changed in colour.

EXPERIMENT XVII.

Paper stained with turmeric, has its colour changed to an orange brown, showing the presence of a minute quantity of an alkaline salt, this being the distinguishing and most delicate test imaginable of an alkali; but fixed alkalis, according to Kirwan, are incompatible with earthy salts; and if common salt, according to Bergman, be accompanied with fixed alkalies in any proportion, then all earthy salts must be absent; but as we have ascertained already the presence of a large quantity of earthy carbonats, fixed alkaline salts were not to be expected here, but in very minute quantity.

EXPERIMENT XVIII.

In order to ascertain whether any magnesian salt was present, I made use of the method proposed by

Dr. Wollaston to detect it. To a glass of this water sufficiently concentrated by boiling, I added a little carbonat of ammonia; no precipitate took place, as carbonat of ammonia has not the property of precipitating magnesia from its compounds; but on adding a solution of phosphat of soda, a white cloud immediately appeared, and a flocculent precipitate was thrown down, which was magnesia, forming an insoluble triple salt, with the phosphoric acid and ammonia.

EXPERIMENT XIX.

Pure ammonia produces no cloud when the water is boiled, which shows that it is not so delicate a test of magnesia as that pointed out by Dr. Wollaston, in the former experiment.

EXPERIMENT XX.

Nitrat of silver and mild nitrat of mercury, affect the water in the same manner as when fresh from the well.

EXPERIMENT XXI.

Oxalat of ammonia scarcely produces any effect.

EXPERIMENT XXII.

Tincture of Galls and *Prussiat of Potash*, alter in no degree the transparency of the water.

Inferences to be drawn from the above experiments.

Though the use of tests or reagents afford no certain conclusion of the exact proportion of any substance which a mineral water contains, yet they determine with accuracy what are the principal ingredients in it; and the experienced chemist, who has been accustomed to such experiments, is enabled to judge even of their quantity with some degree of accuracy. By this means his future experiments are conducted with more precision, and when he proceeds to evaporation, much time and labour is spared in looking for those substances which he had previously ascertained by reagents were not present.

Thus having found by reagents, that this water contains marine acid combined with a base in large quantity, and by Experiment IX. that not the least appearance of sulphuric acid can be traced, our experiments for this purpose, after evaporation, become much more simplified.

Having also discovered by Experiments IV. and V. that iron is present in this water, and ascertained that it was held in solution by the carbonic acid, it was in vain after evaporation to look for any metallic salt, and we have only to determine the quantity of iron which is thus suspended.

Experiments I. and III. have shown the presence of a large quantity of carbonic acid gas; they also decide that this water is supersaturated with this gas, or holds a quantity of it in a free state.

Experiments V. and X. have decided that both iron and lime are held in solution by this gas.

We have also found that magnesia is present in this water, partly suspended by the carbonic acid and partly by a fixed acid.

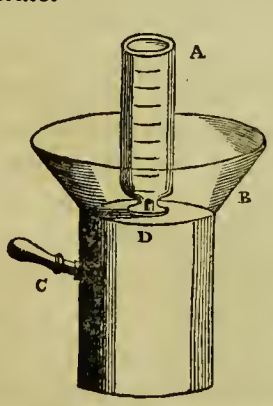
It now remains by evaporation and more direct experiments to confirm these, as well as to determine the quantity of each substance in a given portion of the water. For this purpose I commenced with a few preliminary experiments.

Examination of the Gaseous Contents.

As many of the most important effects of the waters both of Ballston and Saratoga arise from the gas with which they are impregnated, there was no part of the analysis to which my attention was more particularly directed.

At such a distance as Ballston from any place where a mercurial pneumatic apparatus was to be obtained, I was obliged to have recourse to more simple methods of analysis.

Different methods suggested themselves to me, but after repeated trials and mature deliberation, I found that the instrument which I shall now describe and a plate of which is here annexed, was the most simple and accurate.



A. A graduated bottle placed over the tube of the tin vessel.
B. The rim of the vessel which retains the water.
C. The handle of the vessel.
D. The tin vessel calculated to hold one quart of water.

This instrument has been highly approved of by Professors Cox and Cooper, and I hope may be found useful by those who are led to prosecute such experiments.

I procured a tin vessel which was calculated to hold exactly one quart or 57-750 cubic inches of water; a cover was soldered on it, and no opening left except one at the top, one third of an inch in diameter, to which was soldered a tin tube near half an inch long and of the same dimensions as the opening. To the upper edge of the vessel was soldered a sheet of tin about four inches high, which went round the vessel and retained any water that escaped during the process of boiling. This vessel was filled with water at the well to the top of the tube, and immediately after, a decanter of rain water heated to the temperature at least of 120, was placed over it; this decanter having previously been graduated with great care into cubic inches, which were marked with a file on the outside. The vessel was then placed on a steady fire, and heat applied sufficient to boil the water in it. In a very few minutes gas was seen to arise from the water in the vessel, which, having no other place to escape, passed up into the decanter which was placed on it, and was there collected, as water of so high a temperature as that in the bottle was incapable of absorbing any of it. This extrication of gas took place very rapidly; and as the water was displaced from the decanter, it was collected and retained by the tin rim which was attached to the

cover of the vessel. By this means the bottle may be removed and another applied during the process.

When the whole of the gas was extricated, the bottle was taken off and placed on a small vessel of rain water, till the expansion of the gas by heat was reduced to the temperature of 60. Having made repeated trials in this manner, I found that the whole of the gas which was extricated from one quart of the water amounted to 63 cubic inches, which was nearly six cubic inches more than its own bulk, a quantity which as yet, as far as I can find, has never before been detected in any water. According to the synoptical table given by Dr. Saunders, and I know no better authority, none of the numerous mineral waters which he describes are stated to contain their own bulk of gas. Pyrmont, Seltzer, and Spa, are said to contain the most, and none of them exceed 52 cubic inches to the quart.

To ascertain the nature of this gas, I passed it repeatedly through fresh lime water; and after the bottle had remained in a vessel of lime water till no farther absorption took place, I found the whole had been taken up except $2\frac{1}{2}$ cubic inches, which I afterwards examined by a lighted taper and found it incapable of supporting flame; of course as it escaped the action of lime I concluded it to be azotic gas. This gas, which has been only lately detected in mineral waters, is but sparingly soluble in water,

and in a medicinal point of view, it is not suspected to possess any particular qualities. The importance, however, of carbonic acid, both as a menstruum in suspending various substances, as well as its qualities in medicine when water is highly saturated with it, demands our more particular attention.

From the above experiments, it will be seen that one quart of the water of Lowe's Well contains of

	Cubic Inches.
Carbonic acid gas - - -	60½
Azotic gas - - - - -	2½
	63

Examination of the substances held in solution by Carbonic Acid.

In order to collect those substances which were suspended in the water, or rather held in solution by the carbonic acid, and to obtain them separately for examination, I boiled two pints of the water in a glazed earthen vessel for a quarter of an hour.

When the water became heated, air bubbles began to arise in great abundance; the water then became turbid, a pellicle appeared on its surface, and as the carbonic acid was expelled, a light brown powder was deposited; it was then let cool and afterwards filtered with great care. When the whole of this powder was collected from the filter and dried in a temperature somewhat above 150, I found that it weighed exactly 9½ grains.

This powder, consisting of the earths and iron which former experiments proved were held in solution by the carbonic acid, it now became necessary to examine.

It was accordingly exposed for three weeks to the sun, and frequently moistened in order to reduce the iron to the highest state of oxydation. Distilled vinegar was then poured on it, when a smart effervescence took place; it was let remain in a vial bottle for 24 hours, repeatedly stirring it and adding small quantities of distilled vinegar while any effervescence

continued, and till the whole of the earths were taken up. The solution was then filtered, and the residuum which resisted the action of the acid was dried in a dull red heat; it then weighed only one grain; it was of a dark red colour, and was of course an oxyd of iron or rather a peroxyde; being, according to Chenevix, in the 4th or highest state of oxydizement; in this state it is not magnetic, and according to his statement it weighs as 189 to 100 of metallic iron.

The solution in distilled vinegar was now evaporated slowly in a glass dish over a lamp till dry, when a confused filamentous crystallization took place. It was then dissolved in a sufficient quantity of distilled water, and submitted to the following experiments.

The chief purport of these experiments was to ascertain whether the precipitate, consisting of $8\frac{1}{2}$, which had been taken up by the distilled vinegar, was carbonate of lime or magnesia, or both. Accordingly, to a small portion of it was added a few drops of oxalat of ammonia; an immediate white cloud appeared; when to another portion a few drops of sulphuric acid was added, an immediate deposition of sulphat of lime took place. This decides the presence of carbonat of lime in the solution.

To another portion, pure ammonia was added, but no change took place; this shows that neither magnesia nor alumen were present, as, according to Thomson, pure ammonia precipitates these two earths, but no others. Lime water also remained

unchanged when added to a part of this solution. This is another proof of the absence of magnesia and alumen, as it only precipitates these two earths provided no carbonic acid is present.

It therefore appears that the whole of the earth which was deposited by boiling one quart of the water, was carbonat of lime, and that it amounted only to 8½ grains; and that the whole of the iron which fell down from the same quantity was one grain. Small as this quantity of iron appears to be, it was much more than was indicated by tests, and fully as much as could be held in solution by the quantity of carbonic acid which the water contains.

Having tried many methods of obtaining the whole of the iron in a given quantity of water, I found none more effectual than the above. Experiments of this kind frequently repeated lead to many useful practical results; but if it is expected to obtain the whole of the earths by merely boiling the water, it will be seen hereafter that it cannot be done. Here I conceived that I had obtained them all, and that a quart of water only contained 8½ grains of carbonat of lime, when in fact this was scarcely one third of the quantity of earths which it contained, as will be seen hereafter.

In accounting for this, it may be observed that the iron is held in solution by carbonic acid with much less force than the earths, and therefore that it is the

first to precipitate, which it does even without heat, as may be seen when the water is exposed to the atmosphere. Next falls the lime; and last of all, the magnesia, which is so much more soluble that the greater part of it is not precipitated by mere boiling the water, nor will the whole be collected till the evaporation is nearly finished.

We have now to conclude, from the above experiments, that $9\frac{1}{2}$ grains of solid contents precipitated from merely boiling and filtering the water consists of

	Grains.
Oxyd of iron - - - -	1
Carbonat of lime - - - -	$8\frac{1}{2}$
	$9\frac{1}{2}$

Examination of the Solid Contents of Ballston Water collected by evaporation.

It would not be difficult to form a tolerable accurate judgment of the contents of this water from the description which I have already given, and from the tests which have been applied; but no certain conclusion can be drawn of the proportion in which the several substances exist in a given quantity of the water, without submitting it to evaporation, and separately examining those substances.

With this intention I now proceeded to evaporation. One quart or 57·750 cubic inches from Lowe's Well was placed in a flat Wedgwood's dish. This dish was placed in a sand bath over a steady fire, and heat gradually applied, but never so high as to reach the boiling point. As soon as the water was heated to about 90, the same appearances took place as have been previously described; first a considerable extrication of gas took place, then a pellicle appeared on its surface followed by a deposition on the bottom and sides of the vessel, which increased as the evaporation went on, and assumed, during the progress of it, a brown colour. The process continued for four hours, till the water became gelatinous, and crystals resembling common salt, began to appear, which, as they formed, fell down to the bottom. I allowed the whole mass to crystallize together till it assumed the

appearance of a light brown powder, which, when collected and dried in a heat somewhat less than that of boiling water, was found to weigh precisely 72 grains.

This powder, when exposed to the atmosphere, showed no signs of deliquescence, nor was it sensibly increased in weight.

As the degree of heat which is used in desiccation of the precipitate is of great importance, it is necessary to observe, that on every occasion I made use of a lamp or tin vessel, as described by Dr. Marcet in his analysis of Brighton water; and having repeatedly evaporated the water of this well during my stay, both in dry and in wet weather, I scarcely ever found a deviation of more than a grain in the quantity of solid contents which were obtained when desiccated in the manner I have described.

This powder, weighing 72 grains, being the whole solid contents from one quart of water, was digested in a sufficient quantity of alkohol for twenty-four hours, shaking the phial repeatedly, and assisting the solution by a gentle heat, having previously determined the strength of the alkohol by ascertaining its specific gravity, which I found to be 825. The solution was then filtered; and I found, after drying the residuum in the same manner, that it weighed only 65 grains; so that the alkohol had taken up 7 grains.

The residuum, which had escaped the action of alkohol, weighing 65 grains, was now digested for

some time in a sufficient quantity of distilled water, till a complete solution of whatever salts it contained had taken place. This solution was then filtered, and a light brown powder was left on the filter, which, when dried, was found to weigh exactly 22 grains; so that the aqueous solution contained 43 grains. This powder, weighing 22 grains, which resisted the action of alkohol, and was insoluble in eight times its weight of distilled water, was nearly similar to that which was before obtained by filtration from the same quantity of water that had been only boiled for a short time. In both these cases it had been held in solution by the gases, or had been mechanically suspended in the water; but as the quantity obtained by evaporation amounted to 22 grains, while only 9½ grains were deposited after boiling, we may infer that the whole of the earths are not precipitated till the evaporation is nearly concluded, as I have before observed.

It now became necessary to examine this powder; and having, from previous experiments, ascertained that it could be nothing more than carbonat of lime or carbonat of magnesia, or both, combined with a small quantity of oxyd of iron, nothing more was required than to determine the proportion of each. A variety of methods presented themselves; one of them would have been very easy, viz. the precipitation of the lime by oxalat of ammonia, and calculating by the weight of the precipitate of oxalat of lime, what proportion of carbonat of lime the residu-

um contained. But it must be recollected that oxalic acid precipitates also magnesia, and forms with it an insoluble compound, though perhaps not with the same facility that it does lime, yet still it is impossible to prevent its action.

I had, therefore, recourse to a method which I had, from repeated experiments, found easy and sufficiently correct.

The residuum which had been exposed to the rays of the sun for a fortnight, and frequently moistened, assumed a dark brown colour from the perfect state of oxydation which took place in that part of it which consisted of oxyd of iron. It was then digested in distilled vinegar for several hours, while any effervescence continued, and until the whole of the carbonats were taken up, which was sufficiently ascertained by watching the progress with litmus paper.

I must here observe, that distilled vinegar, though of the purest kind, is slow in its operation; it holds but little of the earths in solution, and it is requisite to continue adding small quantities of the acid, while the least appearance of effervescence takes place.

I found, by examining the solution with prussiat of potash, that it gave scarcely any appearance of iron, its high state of oxygenation rendering it insoluble in distilled vinegar.

The whole of this was then poured upon a filter, and a small quantity of a red powder, which was insoluble in the distilled vinegar, was now carefully

collected, and having been dried in a heat of about 200, was found to weigh one grain. This agrees with former experiments, and satisfactorily proves that one quart of the water of Lowe's Well contains,

Of oxyd of iron - - - 1 grain.

We shall now proceed to examine the three different solutions in order to estimate their contents, and to calculate the proportion of the different substances which exist in a quart of water.

Examination of the Solution in Alkohol.

This solution may contain muriat of lime and muriat of magnesia, sulphat of iron, or nitrats of lime and magnesia. The two first of these salts were those which we were now to look for, having previously ascertained their presence. Sulphat of iron, we have already ascertained, does not exist; and nitrats of any kind were not to be expected.

It would have been easy, in this case, to determine the quantity of muriat of lime which was present, by decomposing the muriat and precipitating the lime by oxalat of ammonia, and calculating by the weight of the precipitate of oxalat of lime, what proportion of it was equivalent to any quantity of muriat of lime

which was contained in it. This method was used with success by Dr. Murray, in his very able analysis of the waters of Dunblane; but in that case he had previously ascertained that the water did not contain magnesia, and that as the whole of the salts were muriat of soda and muriat of lime, the latter would be easily separated by the oxalat of ammonia.

This mineral water being, however, of a more compound nature, and containing both carbonats of lime and magnesia as well as muriats of both, the same mode of analysis could not be pursued.

In order to examine this solution, I proceeded to evaporation in a glass vessel over a lamp, till an appearance of crystallization took place, and continued the heat to dryness. The taste of this was saline and acrid, and on exposure to the air it became deliquescent. A few drops of sulphuric acid were now applied to this residuum, placed in the bottom of a Florence flask over a lamp; immediately the fumes of muriatic acid appeared, which, on raising the heat, were all expelled, and the heat was continued till any excess of sulphuric acid was expelled.

A small quantity of distilled water was then added to the dry mass, sufficient to take up any sulphat of magnesia which may have been present. It was then filtered, and the sulphat of lime, which fell to the bottom, was collected on the filter, when dried with a strong heat was found to weigh $6\frac{1}{3}$ grains; which, according to Bergman, would have been produced

from the decomposition of $4\frac{1}{4}$ of muriat of lime, so that deducting this from the 7 grains which the alkoholic solution contained, leaves $2\frac{3}{4}$ grains of muriat of magnesia, converted now into a sulphat, and soluble in the distilled water. However, to ascertain that this did contain sulphat of magnesia, I poured a few drops of pure ammonia into it, when an immediate precipitation of magnesia took place.

Thus we have ascertained that the solution in alkohol contained, of

	Grains.
Muriat of lime - - - -	$4\frac{1}{4}$
Muriat of magnesia - - -	$2\frac{3}{4}$
	7

Examination of the Solution in Distilled Water.

This solution, which consisted of 43 grains of saline contents, was examined in the following manner:

Upon being evaporated very slowly in a glass vessel nearly to dryness, the whole of it crystallized, forming beautiful cubic crystals, which had the taste and appearance of common salt. To determine the nature of this salt, a few drops of concentrated sulphuric acid was poured on some of it, when the peculiar smell and smoke which was produced, in-

dicated the presence of muriatic acid. A few grains of the salt was now dissolved in distilled water; to this was added a few drops of nitrat of silver, when a thick white cloud was immediately produced, so that no doubt could arise of this salt being the muriat of soda or common salt.

A little of this salt was then dissolved in water, to which a few drops of muriat of barytes were added, but no change took place; which showed that no salt, containing the sulphuric acid, was present; neither pure ammonia or phosphat of soda, after carbonat of ammonia, when dropped into a solution of this salt, produced any cloud; which showed the total absence of magnesia.

Oxalic acid produced no change when added to it, which shows that no lime was present.

It therefore follows, that the whole of the contents of the aqueous solution was muriat of soda, and that one quart of the water of the well contains,

Of muriat of soda, or common salt, } 43 grains.

Examination of the Solution in Distilled Vinegar.

The residuum which had escaped the action of alkohol and of distilled water, we have seen weighed 22 grains; having submitted this to the action of distilled vinegar, we have found that the whole of it was dissolved except one grain, which proved to be an oxyd of iron.

The solution in distilled vinegar, it now only became necessary to examine. It was accordingly evaporated slowly to dryness, when it left a filamentous substance which had a bitter acrid taste, and was deliquescent when exposed for a few days to the atmosphere. This decided what I had indeed previously proved, that it contained not only lime, but magnesia. I therefore took the whole residuum and dissolved it in a small quantity of distilled water. I then added a few drops of sulphuric acid, which instantly caused a turbid appearance. This acid was added as long as any precipitation took place. It was then filtered, and by filtration I obtained 20 grains of a white powder, which was selenite or sulphat of lime. Now as, according to Bergman, 100 parts of selenite contain 34 of pure lime, the 20 grains which we have here obtained would amount to about $7\frac{1}{2}$ of pure lime, which is equivalent to $13\frac{1}{2}$ of carbonat of lime, the state in which it is found in this water.

The remainder of the solution was then evapo-

rated and crystallized, and found by its taste and crystallization to be sulphat of magnesia. The $13\frac{1}{2}$ grains being subtracted from 21 grains, which the solution in distilled vinegar contained, leaves $7\frac{1}{2}$; we have therefore to calculate that this solution contained

	Grains.
Carbonat of lime	$13\frac{1}{2}$
Carbonat of magnesia	$7\frac{1}{2}$
Total,	21 grains.

The analysis having been in this manner completed, the whole solid contents obtained from one quart of the water from Lowe's Well, may now be stated as follows:

	Grains.
Of muriat of soda	43
Carbonat of lime	$13\frac{1}{2}$
Carbonat of magnesia	$7\frac{1}{2}$
Muriat of lime	$4\frac{1}{4}$
Muriat of magnesia	$2\frac{3}{4}$
Oxyd of iron	1
Total,	72 grains.

Of aëriform fluids:

	Cubic Inches.
Carbonic acid gas	$60\frac{1}{2}$
Azotic gas	$2\frac{1}{2}$
	63

Analysis of the Public Well at Ballston.

The sensible qualities of this well are in every respect precisely similar to Lowe's Well, an account of which has been already given very fully.

Its temperature is 52.

Specific gravity as 1008 to 1000.

The application of reagents produced exactly the same appearances in the water of this spring as I have described when treating of Lowe's Well; indicating, therefore, the presence of the same ingredients. As a repetition of these, here, would answer no useful purpose, I shall proceed to ascertain with precision the exact proportion of each ingredient as they appear after evaporation.

But previous to evaporation, it was necessary to make such experiments as would determine the quantity and quality of the gaseous contents. The taste and appearance of the water gave me no reason to suspect that in this respect I should find much difference between these two springs, and I was not disappointed, for after having repeatedly expelled its gas in the same manner and with the same vessel which I have already described, I found that a quart of this water contained,

	Cubic Inches.
Carbonic acid gas - - - -	61
Azote - - - - - -	$2\frac{1}{2}$
	$63\frac{1}{2}$

A difference so trifling that it was scarcely perceptible, and should certainly be set down as of no consequence, as the same difference has taken place when examining the same waters at different times.

A quart of this water was now submitted to evaporation. The same extrication of gas took place when heat was applied; a pellicle of a light brown colour appeared on its surface, which soon fell to the bottom; the water then became turbid, and a precipitation appeared, which gradually increased during the progress of evaporation. When the process was finished, and the whole of the residuum was collected and dried at nearly the temperature of 212, it was found to weigh 69 grains.

These 69 grains were then submitted to the action of alkohol of as high specific gravity as 825. The solvent action of this fluid being assisted by the heat of the sun, and frequent agitation of the mixture, after being digested in this manner for 24 hours, it was then filtered, and the residuum which was collected on the filter and dried, was found then to weigh only 64 grains; so that the alkohol had taken up 5 grains.

To these 64 grains I added eight times its weight of distilled water, assisting the solution by a very slight heat, and agitating the bottle till I conceived the water had taken up the whole of the salts which were soluble in it. The mixture was then filtered, and the residuum which was insoluble in water, when dried, was found to weigh precisely 22 grains.

These 22 grains I found, according to previous experiments, were the calcarious and magnesian earths combined with a portion of iron, and that they were held in solution in the water by an excess of carbonic acid. It was necessary to separate those earths, and to determine also the quantity of iron: for this purpose I proceeded as in the analysis of Lowe's Well. The residuum was exposed for two or three weeks to the rays of the sun, occasionally moistening it; by this means the iron became highly oxygenated, and it assumed a much darker colour; it was then submitted to the action of distilled vinegar as long as any effervescence took place, and till nothing more could be dissolved. This solution was then filtered, and the residuum on the filter carefully collected and dried, when, as was the case in Lowe's Well, I now obtained one grain of oxyd of iron, the peroxyd or red oxyd of Thomson.

We have now three solutions to examine, which are as follows: 1st, the solution in alkohol; 2d, that in distilled water; and 3d, that in distilled vinegar. Without repeating the whole of the reasoning in the analysis, I shall briefly attend to them.

1st. The solution in alkohol was evaporated over a lamp to dryness, when it was found to weigh only 5 grains; it was extremely deliquescent, and had an acrid taste. Reasoning from analogy as well as from experiment, I had no reason to doubt but this was either muriat of lime or muriat of magnesia, or perhaps both; but to determine this, it was dissolved in

distilled water, and a few drops of sulphuric acid was poured into the solution as long as any precipitate was thrown down.

The mixture was then filtered, and a white powder collected, which was sulphat of lime. This was perfectly dried and weighed, and found to weigh only 4¼; which, according to Bergman, must have been produced by the decomposition of 3¼ of muriat of lime; subtracting this from the 5 grains which the solution contained, leaves 1¾, the quantity of muriat of magnesia contained in a quart of water.

2d. The solution in distilled water was next examined. We have seen that it had taken up 42 grains of salts; to determine the qualities of this salt, was all that was required. The solution was accordingly evaporated slowly in a china vessel; as the evaporation went on, cubic crystals of salt appeared, which were apparently marine salt. The whole, when dried at the usual temperature, was collected, and weighed 42 grains. That there should be no doubt of its character, I submitted it to the following experiments: a few drops of sulphuric acid were applied to a portion of it, when immediately the well known fumes of marine acid arose from it. A small quantity of this salt was dissolved in water, to which was added a few drops of nitrat of silver; a thick cloud immediately appeared. To another portion dissolved in water a few drops of muriat of barytes was added, but no change took place; we see, therefore, that no sulphats or salts, containing the sulphuric acid, were

present; therefore we may venture to pronounce that the Public Well contains 42 grains of muriat of soda or common salt.

We have now only the third solution to examine.

3d. This consisted of 21 grains, which the distilled vinegar had taken up, after having resisted the action of alkohol and distilled water. This solution was evaporated till a confused filamentous crystallization took place. This substance was extremely bitter and acrid; after standing some time it was also found deliquescent, from which I judged it contained magnesia as well as lime. It was accordingly converted into an aqueous solution, and sulphuric acid dropped in while any precipitation took place. The sulphat of lime thus formed, was dried and weighed, when it was found to weigh only 15 grains. Now as 100 parts of gypsum contains 34 of pure lime, the 16 grains obtained in this case should contain about 5 grains, which is equivalent to about 9¼ grains of carbonat of lime. The clear solution, when nothing more could be precipitated, was afterwards crystallized, and regular crystals of sulphat of magnesia were obtained from it. We have now to conclude, that the solution in distilled vinegar consisted of 9¼ of carbonat of lime, and 11¾ of carbonat of magnesia.

The result of the analysis of the Public Well being thus completed, I shall state the contents of the

different ingredients which have been found in one quart of the water, as follows:

	Grains.
Muriat of soda - - -	42
Muriat of magnesia - - -	$1\frac{3}{4}$
Muriat of lime - - -	$3\frac{1}{4}$
Carbonat of magnesia - - -	$11\frac{3}{4}$
Carbonat of lime - - -	$9\frac{1}{4}$
Oxyd of iron - - - -	1
Total,	69

Of aëriform fluids:

	Cubic Inches.
Carbonic acid gas - - -	61
Azotic gas - - - - -	$2\frac{1}{2}$
Total,	$63\frac{1}{2}$

The two principal springs at Ballston having been thus examined with the utmost attention, I have given the result to the public in the most particular manner. Some surprise may be excited at the extreme similitude in the contents of each of these waters, but this is no uncommon circumstance.

Springs at a much greater distance from each other than these, have frequently been found by analysis to possess precisely the same qualities. It would therefore be as invidious as it would be absurd in me, to draw any comparison between the medical qualities of these two springs; in fact, I know

of no difference. It has scarcely ever been found, that exactly the same results have been shown by any two chemists making experiments on the same water. In the present instance, the same substances have been found in each spring. Whatever slight difference has occurred in the proportion of those substances, should therefore rather be attributed to accidental causes, than placed to any other account leading to any serious comparison between them.

Chemical Analysis of the Congress Spring at Saratoga.

External Character, Temperature, and Specific Gravity.

The sensible qualities of this water are extremely similar to those springs at Ballston, which have been already examined. Its temperature is uniformly at all seasons 52. Its specific gravity, when taken with great care and by repeated trials, was found to be as 1012 to 1000; thus it will be seen that it is much greater than the water at Ballston, affording strong proof that its saline contents is in much larger proportion.

The appearances of Saratoga water at the spring are very similar to the description which I have given of the Ballston springs. Great quantities of gas are emitted from the bottom of the well, and passing through the water, burst on the surface. Those bubbles are found to be carbonic acid gas, forming an atmosphere on the surface of the well deleterious to animal life and incapable of supporting flame.

When a glass of the water is first taken from the spring, it is perfectly clear and transparent. Minute air bubbles are seen extricating from it, many of which, in a few minutes, adhere to the inside of the glass.

Owing to the quantity of this gas, if the water is immediately bottled when taken from the spring and

DRAWN BY C.A. LESUEUR

ENGRAVED BY J. HILL

A VIEW OF THE CONGRESS SPRING IN THE VILLAGE OF SARATOGA

well corked in warm weather, the bottles are liable to burst, from the expansion of the air. But no mineral water bears bottling better than this; and when carefully performed, it will bear carrying to any climate, while its essential qualities are but very little impaired. This practice of bottling the water is now well understood, and is carried on at this spring with great success. The demand for it not being alone confined to this country, and as it fortunately happens that the spring is so abundant that the supply of water is inexhaustible, it may hereafter become a lucrative article of commerce.

The taste of the water is highly saline, but brisk and pungent; much more saline than the Ballston water, and rather more stimulating and acidulous.

It has no sensible chalybeate taste, and no smell. Its saline taste being very much counteracted by the smart pungency which it possesses from the carbonic acid, renders it less disagreeable to the palate than it would otherwise be; and after a little use, its taste is by no means unpleasant; on the contrary, it is thought by many a most agreeable drink.

The first effect of it when taken into the stomach, is similar to that of bottled liquor. Most persons feel an exhilaration of spirits and a slight giddiness from the use of it. If taken in sufficient quantity, it constantly shows a purgative effect on the system; but of this quality in both waters, I shall speak more fully when I come to treat of their medicinal qualities.

If a glass of this water is left exposed for an hour or two to the atmosphere, innumerable bubbles of gas arise from it, some of which escape from the surface, the rest adhere to the side of the glass; the water by degrees loses its transparency, a light pellicle appears on the surface, which falling down and increasing, a white powder is deposited on the sides and bottom of the glass. The water then by degrees recovers its transparency, but has lost its pungent and acidulous taste, being perfectly vapid and simply saline.

Examination of the Congress Water by reagents.

EXPERIMENT I.

The colour of *Litmus Paper* is immediately changed from blue to red.

EXPERIMENT II.

Paper stained with Turmeric is not sensibly affected.

EXPERIMENT III.

Muriat of Barytes, when dropped into a glass of the water, produces no change in it.

EXPERIMENT IV.

Neither has *Nitrat of Barytes* or *Muriat of Strontian* the slightest effect on it.

EXPERIMENT V.

Oxalat of Ammonia produces an immediate white cloud and an abundant precipitate.

EXPERIMENT VI.

Lime Water causes an immediate precipitate, even when the Congress water is added only in the proportion of one fifth.

EXPERIMENT VII.

Tincture of Galls has scarcely any sensible effect when first added to the water, but on letting it stand in the glass for some time, a purplish tint is exhibited.

EXPERIMENT VIII.

Prussiat of Potash is very slightly affected by this water. A light green colour after a short time appears, but here there is a very sensible difference between the change produced in this water, and that of Lowe's Well at Ballston.

EXPERIMENT IX.

Nitrat of Silver instantly throws down a dense white sediment sensibly more abundant than in the Ballston water.

EXPERIMENT X.

Acetat of Lead produces also a white cloud and an abundant precipitate, which is soluble in distilled vinegar.

EXPERIMENT XI.

Nitrat of Mercury occasions a copious white precipitate.

EXPERIMENT XII.

Sulphuric Acid, when dropped into a glass of this water, excites an immediate and brisk effervescence more actively than in the Ballston water, after which a white precipitate is thrown down.

EXPERIMENT XIII.

Nitric Acid causes the same extrication of gas, but no precipitate is thrown down.

EXPERIMENT XIV.

Carbonat of Potash produces no change in the water.

EXPERIMENT XV.

Pure Potash, when dropped into a glass of this water, produces an immediate cloud which is followed by a precipitate.

EXPERIMENT XVI.

Pure Ammonia has precisely the same effect; but when a little more of the liquid is added, the precipitate is redissolved; in the first instance, the ammonia takes up the excess of carbonic acid, which holds the earths in solution; but an excess of ammonia deprives the earth of the whole of its carbonat, and it becomes again soluble.

Having made the above experiments with water from the spring, I now proceeded in order to obtain more complete inductions to follow up and repeat some of these experiments after the water was boiled.

I therefore boiled one quart of the Congress water for half an hour, and having filtered it, made the few following experiments.

The precipitate which was left on the filter after boiling amounted to near 20 grains, which was much more than I obtained from the Ballston water; it was also of a much lighter colour, owing to the absence of the oxyd of iron; it effervesced when nitric acid was poured on it.

EXPERIMENT XVII.

Nitrat of Silver produced the same dense white precipitate as before.

EXPERIMENT XVIII.

Acetat of Lead was affected in the same manner.

EXPERIMENT XIX.

Litmus Paper was not changed in colour.

EXPERIMENT XX.

Paper stained with Turmeric has its colour slightly changed to an orange yellow.

EXPERIMENT XXI.

Acids now produce no effervescence.

EXPERIMENT XXII.

Oxalat of Ammonia produces a slight cloudiness, but by no means equal to that which it does when fresh drawn from the spring.

EXPERIMENT XXIII.

Muriat of Barytes has not the smallest effect.

EXPERIMENT XXIV.

Tincture of Galls produces no change of colour.

EXPERIMENT XXV.

Prussiat of Potash has no sensible effect on the water.

From the above Experiments the following Conclusions may be drawn.

From Experiments I. and XVII. that this water contains a large quantity of carbonic acid gas, and demonstrate that it is partly combined and partly uncombined, or in a free state.

Experiments VII. and VIII. show that the Congress water is but very slightly, if at all, impregnated with iron; and that whatever quantity it may contain is in the state of a carbonat. From the different effects of these tests we have reason, however, to infer, that the proportion of iron is much less than in the Ballston water.

Experiments XI. XVII. and XVIII. indicate the presence of muriatic acid in a state of combination; the quantity of the precipitate also shows that it is much more abundant than the Ballston water.

Experiment III. shows decidedly, that no sulphuric acid or sulphats are present.

Experiment V. proves the presence of a large quantity of lime, which is shown by Experiment XXII. to be held in solution principally by an excess of carbonic acid.

Experiments to ascertain the Gaseous Contents of the Congress Water.

In order to determine the nature of the gas with which we find this water so highly saturated, I proceeded in the same manner as I have before described in the analysis of Ballston water, and which I think unnecessary to repeat here. Farther trials have convinced me of the accuracy of the method which I employed; and the experiments on this part of the analysis were so repeatedly made, that I think I may fairly presume that no material error has arisen.

In the water which we now describe, the gas is rather more abundant and free than in the Ballston water; therefore, it requires to be examined in the neighbourhood of the spring, as much of it escapes before the application of heat, though the whole of it is not let loose till the commencement of the boiling point at least. By proceeding in the manner which I before pursued, I have always succeeded in obtaining 68 cubic inches of gas from one quart or 57.750 cubic inches of the water, the greater part of which gas was absorbed by lime water, and of course was carbonic acid; that which was not taken up by lime water never amounted to more than two cubic inches, which, from its quality of extinguishing flame, I have every reason to suppose must be principally azotic

gas. I mention here, however, with regret, that owing to the difficulty of obtaining such an apparatus in this place as an Eudiometer, I was not able to decide whether a portion of these two cubic inches, which escaped the action of lime water, was not atmospheric air; however, this cannot be thought a matter of consequence; certainly none in a medical point of view, as we have no reason to suspect it of medical qualities.

From the above experiments, we conclude that one quart or 57.750 cubic inches of Congress water contains,

	Cubic Inches.
Of Carbonic acid gas - - -	66
Azotic gas - - - - -	2
	68

Examination of the Contents of the Congress Water by evaporation.

The experiments which have been already detailed, throw great light on the qualities of this water, and enable us without difficulty to decide upon the nature, but not on the quantity, of the different substances with which it is impregnated.

We have seen by the use of the same reagents that in many respects there is a great resemblance between the two waters of Ballston and Saratoga; that there is nothing very complicated in their qualities; that they contain the same species of salts; but that they materially differ in the quantity. Tests or reagents, when in the hands of an experienced chemist, are more certain guides than have been generally imagined. Without the use of them, the process by evaporation is attended with confusion and uncertainty. When we know from tests what are the substances to be expected, the experiments by evaporation become more simplified and familiar.

I accordingly proceeded to evaporation in the same manner and with the same quantity of water that I had operated on in my analysis of Ballston spring.

One quart of the water fresh from the Congress Spring was placed in a glazed china vessel, placed in a sand bath over a furnace. Heat was gradually

applied, but never allowed to exceed 180 or 190 of Fahrenheit. The same appearances took place as have been previously described in the analysis of Ballston water. When the gas began to arise, which it soon did very freely, the water became turbid; a white pellicle appeared on its surface, which gradually fell to the bottom, in considerable quantity, but never assumed the brown colour that the residuum from the Ballston water always showed. When the water was nearly evaporated, cubic crystals of salt appeared, which I allowed to subside, and after evaporating the water to dryness, collected the whole of the residuum together; which, when dried in a heat of about 200, weighed precisely 156 grains.

Examination of the Residuum.

The whole of the residuum was submitted to the action of alkohol, with a view to separating the muriats of lime and magnesia from the muriat of soda, with which I had reason to think it was principally composed. The success of this process entirely depends upon the quantity and quality of the alkohol; it is necessary, therefore, to ascertain the specific gravity of the alkohol with perfect precision. That which I used was as high as 825, having been pre-

viously distilled from hot muriat of lime; when of this strength it has no action on muriat of soda. After the entire solid contents obtained by evaporation had been digested in about six times its weight of alkohol, assisted by gentle heat, it was then carefully filtered, and the whole of the undissolved matter dried at the same temperature; it was then found to weigh only 148 grains, so that the alkohol had taken up 8 grains.

On the residuum, which resisted the action of alkohol, and which was now reduced to 148 grains, I poured about eight times its weight of distilled water, and digested it sufficiently long to render any salts perfectly soluble in it; it was then poured on a filter and well washed with distilled water. The whole of what remained insoluble was collected on the filter and dried in the usual manner, when it was found to weigh precisely 45 grains, so that the aqueous solution contained 103 grains of a soluble salt.

The powder which had escaped the action of alkohol, and which was insoluble in distilled water, we have, from the result of former experiments, ascertained to be carbonats of lime and magnesia, combined with a certain proportion of aërated iron, as was the case in our analysis of the Ballston water. There were different methods of separating these, but on this occasion I preferred proceeding in the same manner I had done with the Ballston water; the similarity of both having been so apparent, I

concluded that the results would be equally so. Accordingly, to this powder weighing 45 grains I gradually poured distilled vinegar; an immediate effervescence took place. This process was continued for several hours, stirring the mixture occasionally, and assisting it with a gentle heat, as the action of vinegar is but slow. The process of the solution was attended to by occasionally testing it with litmus paper. When no more action took place, the whole being nearly dissolved, the solution was filtered; but nothing more remained on the filter than a small quantity of a light reddish brown powder, which, when dried in a dull red heat, scarcely amounted to half a grain; this powder was then enveloped in wax and exposed to the heat of a blow-pipe in a platina spoon; it was then reduced to a small quantity of a very dark powder, which was attracted easily by the magnet.

It thus appears that the Congress water, though but slightly affected by the usual tests, and contrary to the general opinion, does contain a small quantity of iron, but by no means so much as the Ballston water.

We shall now proceed to examine the three different solutions which we have made, in the following order.

Examination of the Solution in Alkohol.

This solution, which contained eight grains, was perfectly clear, but had a very bitter taste; and as it generally consists of only muriats of lime and magnesia, I proceeded in the following manner to discover its contents.

I evaporated the whole of the solution to dryness; a white powder appeared, which was very deliquescent when exposed to the atmosphere even for a short time; the whole of this powder was then dissolved in a small quantity of distilled water, thus converting the alkohol solution into an aqueous one. Sulphuric acid was now gradually poured into this solution, till the basis of these salts were saturated, which was judged of by watching the progress with litmus paper; a white powder, which was sulphat of lime, fell to the bottom; this was separated by filtration, and when dried and collected was found to weigh $4\frac{1}{4}$ grains, which, according to Bergman, must have been equal to $3\frac{1}{4}$ of muriat of lime. The solution which remained was then examined with pure ammonia, and found to contain magnesia. Thus it appears that one quart of this water contains $3\frac{1}{4}$ of muriat of lime, which deducted from the 8 grains of salt which was soluble in alkohol, leaves $4\frac{3}{4}$ of muriat of magnesia.

Examination of the Solution in Distilled Water.

In order to examine the contents of this solution, which consisted of 103 grains, I proceeded to evaporation in a glass vessel. Upon evaporating it very slowly, beautiful cubic crystals of salt appeared; the heat was then continued to dryness, when 103 grains of salt were obtained, which was examined in the following manner.

EXPERIMENT I.

On a part of it a little concentrated sulphuric acid was poured, when the fumes and peculiar smell of muriatic acid were instantly produced.

EXPERIMENT II.

A small quantity of this salt was again dissolved in a wine glass of distilled water; to this was added a few drops of nitrat of silver, when an immediate thick white precipitate was produced.

EXPERIMENT III.

A little of this salt was dissolved in distilled water; to this was dropped in a few drops of muriat of barytes, but no precipitate appeared.

EXPERIMENT IV.

To a little of this saline solution a few drops of

oxalat of ammonia were added, but no change was produced in it.

From these experiments it follows, that the whole of the soluble salts in this solution were nothing more than muriat of soda; that it contains neither sulphat of soda or sulphat of magnesia, and that in every respect the saline contents of the Congress Spring are similar to those of Ballston; but that while the Ballston water contains but 43 grains of muriat of soda or common salt in one quart, the Congress Spring contains 103 grains.

Examination of the Solution in Distilled Vinegar.

It having been perfectly ascertained that this solution, which consisted of 47½ grains of solid contents, could be nothing more than carbonat of lime and carbonat of magnesia, which had been held in solution in this water by an excess of carbonic acid, and were precipitated by the process of boiling, I proceeded to examine the contents in the following manner:

I first slowly evaporated the whole of it in the bottom of a Florence flask over a lamp; a substance appeared at the bottom which was very acrid, which

would not crystallize, and was very deliquescent; from these circumstances I had no doubt that it contained magnesia as well as lime. Distilled water was then poured on it, converting it into an aqueous solution. Sulphuric acid was then cautiously dropped in while the least precipitation appeared.

This precipitate, which was an insipid powder, consisted of sulphat of lime; it was then collected on a filter and dried in a strong heat over a lamp, after which it weighed 45 grains. Now as sulphat of lime contains 34 parts of pure lime in 100, the 45 grains of sulphat of lime here obtained will contain about 15 of pure lime, which is as nearly as possible equal to 27½ grains of carbonat of lime, the state in which we find it in this water; when this is deducted from the 44½ grains which the solution contained, it will leave 17 grains of carbonat of magnesia, converted now into a sulphat and soluble in water.

We have thus from one quart of water of the Congress Spring obtained the following substances:

	Grains.
Muriat of soda	103
Carbonat of lime	27½
Carbonat of magnesia	17
Muriat of lime	3¼
Muriat of magnesia	4¾
Oxyd of iron	½
	156

	Cubic Inches.
Carbonic acid gas	66
Azotic gas	2
Total,	68

Chemical Analysis of the Flat Rock Spring at Saratoga.

The external qualities of this spring have so striking a resemblance to those at Ballston as well as to that of the Congress Well, that they are scarcely to be distinguished. Gas arises freely from the bottom, and breaks in the same manner on its surface. This gas, upon examination, proves to be almost entirely the carbonic acid. When the water is first taken up in a glass it is perfectly transparent, and sparkles when poured from one glass into another; its taste is brisk, acidulous, and saline; full as pungent and acidulous as any of the other waters, but by no means so saline as the Congress Well, which renders it at first much more agreeable to the palate; it has no smell, and scarcely any chalybeate taste. When let remain in a glass vessel exposed to the atmosphere it becomes turbid, a light pellicle appears on its surface, and in a few hours a white powder is deposited on the sides and bottom of the glass; after which the water loses its agreeable pungent taste, and becomes simply saline.

The temperature of this spring is uniformly 52°, differing in no respect from any of the others.

Its specific gravity when taken with great care at the temperature of 60, is as 1007 to 1000.

With tests or reagents it exhibited the following appearances:

Litmus Paper was immediately changed from a blue to a red colour, but this could not be made appear after the water had been long exposed to the atmosphere.

Paper stained with Turmeric is not changed in its colour either when fresh from the spring or when the water is boiled.

Lime Water produces an immediate turbidness, and a copious precipitation takes place when added in certain proportions. One part of the mineral water to three parts of lime water will be sufficient to produce this effect, exhibiting strong proof of the quantity of carbonic acid gas which the water contains. Having explained this fact before in the analysis of Lowe's Well, I shall only here observe that I have by repeated experiments found that very correct inferences of the quantity of carbonic acid gas which exists in a mineral water, may be drawn, by the quantity of it which is necessary to decompose lime water.

Tincture of Galls scarcely produces any effect on this water when fresh taken from the well; but if let stand in the glass for some hours, it assumes a light purple colour.

Prussiat of Potash, when first dropped into this water, has no sensible effect; but if a drop or two of muriatic acid is added previously, and the glass let stand for some hours, a light green colour is produced, indicating that but a very small quantity of iron is present.

Nitrat of Silver, when dropped into a glass of this water, immediately throws down a very dense white precipitate.

Muriat of Barytes does not alter the transparency of the water.

Oxalat of Ammonia produces an immediate white precipitate when the water is first taken from the well, but has no such effect when the water is boiled.

Sulphuric Acid produces a very brisk effervescence when dropped into the water; after which, a precipitate of sulphat of lime takes place.

Carbonat of Ammonia does not disturb the transparency of the water.

Carbonat of Potash has no effect on the water.

Pure Ammonia, when dropped into the water, immediately throws down a white precipitate.

Pure Potash has precisely the same effect, and for the same reason, as it deprives the water of that excess of its carbonic acid which hold the earths in solution.

These preliminary experiments were sufficient to satisfy me that the water of the Flat Rock Spring was possessed of the same qualities as those which I had already examined, though some of those tests had convinced me that it differed essentially in the quantity of its saline contents in particular.

In order to determine this, I had recourse to evaporation, the only true criterion, the enquiry having been much simplified by the results of the above trials.

Having found that this water contained a large proportion of gas, I proceeded to ascertain its quantity, and quality, in the same manner that I have already described, and which I found easy and successful. From the result of my experiments I found that one quart of the water contained, of

	Cubic Inches.
Carbonic acid gas - - -	66
Azote - - - - - -	1½
Total,	67½

One quart wine measure or 57.750 cubic inches, was now evaporated with great care and with a heat that never arose to the boiling point. Precisely the same appearances took place as in the evaporation of

the Congress water; it first became turbid, and then, as the quantity of water diminished, a white precipitate gradually fell to the bottom; the evaporation having been continued to dryness, the precipitate or residuum was carefully collected and dried, when I found it to weigh only 71 grains,—showing a very great difference indeed between the solid contents of this spring and that of the Congress well.

The whole of the residuum was now submitted to the action of alkohol of high specific gravity, which was poured on it in a phial and repeatedly shaken for some hours, assisted by a slight heat. The solution was then filtered, and the residuum collected on the filter, which, when dried in the same temperature, was found to have lost 4 grains, weighing now only 67 grains; to these 67 grains I poured on about eight times its quantity of distilled water; as soon as the solution was complete, the mixture was again filtered, and the residuum in this case now dried and weighed—when it was found to be reduced to 26 grains, the distilled water having taken up 41 grains.

The residuum which was insoluble in water, consisting only now of 26 grains, was submitted to the action of distilled vinegar in order to ascertain the quantity and quality of the earths which were insoluble after boiling the water. A brisk effervescence took place; the distilled vinegar was gradually added till a complete solution took place, except of such a small quantity of a brown powder that it did not consist of the $\frac{1}{4}$ of a grain. By heating this powder,

however, on charcoal rolled up in a little wax, what remained showed sensibility to the magnet, which proved that it was the iron which had previously existed in the water in the state of an oxyd.

The different solutions remain to be examined, in order to determine the precise contents of each. First, that in alkohol consisting only of four grains, was slowly evaporated to dryness over a lamp; in this state, however, it remained but a very short time, becoming almost immediately deliquescent, and having an extremely bitter taste; it was then dissolved in distilled water, and examined in the following manner:

To a part of it I added a few drops of oxalat of ammonia, but no change took place. To another part I added a little carbonat of ammonia; no change took place, till phosphat of soda was added, when an immediate white flocculent cloud appeared, which showed decidedly the presence of magnesia.

To a little more of this solution nitrat of silver was dropped in, when a thick white precipitate fell down.

Thus I have found that this solution contained no lime, but that it contained magnesia exclusively and muriatic acid. This therefore was the only one in which I had not discovered muriat of lime; the whole of these four grains, which were taken up by the alkohol, being muriat of magnesia.

The second solution, being the aqueous one, and which had taken up 41 grains, was now slowly eva-

porated in a glass vessel over a lamp. Beautiful cubic crystals soon appeared; the whole was evaporated to dryness in order to examine this salt, which with the usual tests, unnecessary here to repeat, was found to be wholly muriat of soda or common salt.

The last or third solution, which consisted of 25¾ grains, taken up by the distilled vinegar, was next examined to discover whether it consisted wholly or in part of carbonat of lime, or wholly or in part of carbonat of magnesia; for this purpose it was evaporated slowly till a viscid mass was obtained, which could not be brought to crystallize, and which was deliquescent. This residuum not only showed the properties of acetat of lime, but also of magnesia; it was accordingly converted into an aqueous solution, and the whole of the lime thrown down, by converting it into a selenite with a few drops of sulphuric acid. The precipitate thus formed, was dried and weighed, when I found it to weigh 25 grains; now as, according to Bergman, 100 parts of gypsum contains 34 of pure lime, or what is nearly equal, to 62 of carbonat of lime, the state in which of course it must have existed in the mineral water, the 25 grains which we have here obtained is equivalent to about 15½ grains of carbonat of lime. The remainder, when evaporated, produced perfect crystals of sulphat of magnesia or epsom salt. Of course if we deduct 15½ from the 25¾ grains which was held in solution by the distilled vinegar, we shall find its contents

to be in the following proportions in one quart of water:

	Grains.
Carbonat of lime - - - -	15½
Carbonat of magnesia - - - -	10¼
Total,	25¾

The analysis of Flat Rock Spring being now complete, I shall state the whole of the contents of one quart of the water to be, as it appeared to me, as follows:

	Grains.
Muriat of soda - - -	41
Carbonat of lime - - -	15½
Carbonat of magnesia - - -	10¼
Muriat of magnesia - - -	4
Oxyd of iron - - - - -	¼
	71

Of aërial contents:

	Cubic Inches.
Of Carbonic acid gas - -	66
Azotic gas - - - -	1
	67½

The two principal springs at Saratoga having been thus examined, I shall make but few observations in this place on their comparative contents, which are too striking to escape our notice. While the two wells at Ballston show no sensible difference, it appears that the Congress and Flat Rock springs at Saratoga differ most essentially; not so much in the

quality as the quantity of those substances with which they are impregnated.

While the Congress spring contains 103 grains of muriat of soda in one quart of its water, the Flat Rock contains only 41; while the Congress spring contains 44½ of carbonat of lime and magnesia, the Flat Rock contains only 26. Thus the difference is so very essential that it deserves particular attention, because the effects of the two waters on the system must also materially differ. To point out, however, the medical qualities of each, must be the subject of another part of this work. In the next chapter I shall make some observations on the chemical contents of mineral waters in general; and in doing so, I shall enter into the qualities of these and other saline waters, referring to a Synoptical Table which accompanies it, and which will show what has been ascertained to be the solid as well as gaseous contents of these, as well as the most celebrated waters in Europe.

CHAPTER III.

General Remarks on the Composition of Mineral Waters, and on the Sensible and Physical Qualities of the Waters of Ballston and Saratoga, as resembling those most celebrated in Europe.

HAVING thus I trust faithfully given the result of my experiments on the principal waters of Ballston and Saratoga, I shall proceed to make some observations on their nature and properties, before I commence an important part of this work, an enquiry into their medical qualities.

On this subject, as well as on their component parts, I shall perhaps differ from the opinions of many who have preceded me. Had there before appeared any work on these waters sufficiently accurate, I should not now have been induced to enter into this investigation. Although the result of my analysis differs in many respects from every other, yet many of the conclusions which are drawn by Dr. Seaman, in his treatise on the subject, are correct and judicious. To him more than to any other writer, are we indebted for much important information; but since the publication of his work, a new era has taken place in chemistry. To supply those parts, therefore, in which he is deficient, required new and additional experiments, which may have been before expected from his own skill and judgment.

Since the publication of his work, an analysis has appeared in a letter to Dr. Hosack, said to be the work of a celebrated French chemist. Coming from such authority, great confidence has been placed in it; but with all that respect for the talents and judgment of Dr. Hosack to which he is so eminently entitled, I must say that I never met with a more unsatisfactory or incorrect analysis than that which has been furnished him by his correspondent. It affords, however, Dr. Hosack an opportunity of making some observations on the medical qualities of those waters, so sound and so judicious as to compensate in some degree for the defect of the analysis.

The principal error of this analysis, as said to be performed in France, is the assertion that the waters of Ballston contain three times their own bulk of carbonic acid gas. This error is so great, that it is not improbable it was a typographical one, or a mistake in the translation, as we know, according to the statement of Bergman, Kirwan, and others, that water at the temperature of 52 can hold little more than its own bulk under the common pressure of of the atmosphere, and I have found this to be the case by my own experiments on the spot. If, therefore, the water does not contain it at the fountain, how could it be possible to obtain any such quantity from it when examined after so long a time as it must have taken to transmit it to France.

The next mistake, which is a very important one,

is the assertion that one pint and a half of Ballston water contains four grains of carbonat of iron. To refute this opinion, besides referring to my own experiments, I need only state, that no water ever did or ever could contain so much; that according to the assertion of the most able chemists, it requires 100 cubic inches of carbonic acid gas to hold one grain of iron in solution, and that this water does not contain much more than half this quantity of gas in a pint and a half measure. My statement, which gives one grain of iron to the quart of water, exceeds even the usual calculation, and I am confident is as much as the water really contains. Small as this appears to be, it is more than I believe has ever been allowed to be present in the most celebrated chalybeates, such as Tunbridge Wells in England.

The statements which are given in the French analysis, of the nature and proportions of the saline ingredients, are by no means so incorrect, and do not essentially differ from what I have found them.

Many mineral waters of established reputation, when chemically examined, have been found to contain so small a quantity of neutral salts, and some of these so inert in their nature, as to excite some surprise that the effect of such waters on the system should be so powerful. The attempts which have been made to reconcile the effects of these waters with their chemical qualities, have been in most instances fanciful or absurd. This question has been treated lately very ably by Dr. Murray, in his analysis

of the waters of Dunblane. He observes very justly that this subject is of much importance in a medical point of view; and if his suggestions, strengthened as they are by the opinion of Kirwan, are susceptible of proof, they go a great way in removing many of those difficulties which we long lay under, in explaining the "modus operandi" of mineral waters.

Kirwan, when treating on the subject of evaporation, observes, "That mineral waters frequently contain incompatible salts, which being brought together by close evaporation, they decompose each other, and thus salts are exhibited which the water did not originally contain."

Dr. Murray follows up this view of the subject, and observes, that "in cases where a mineral water contains several distinct ingredients, many of them may be changed or decomposed in the progress of evaporation, and one of them may be the product of the operation, which did not exist in the water as an original ingredient."

Thus when we collect, after evaporation, sulphat of lime, muriat of soda, and muriat of lime, in small quantity, it leads us naturally to the conclusion that these are the real or original ingredients; but it is not improbable that when the liquor becomes concentrated during the progress of evaporation, new compounds take place. The sulphuric acid may have acted on the muriat of lime which was contained in the water, and by mutual decomposition convert that muriat into a sulphat of lime, and the muriat of

lime into a sulphat of soda; and it is here suggested that this is rendered more probable from the purgative qualities which these waters originally possessed, which could easily be accounted for if they contained sulphat of soda, the state in which the sulphuric acid originally existed, but could not be produced by so inert a substance as sulphat of lime.

This is only one example, and if it was capable of direct proof, would greatly facilitate our knowledge of the component part of mineral waters, and go a great way to explain some of their important effects on the system. But for a very learned and scientific discussion of this subject, I must refer the reader to the work of Dr. Murray on the mineral waters of Dunblane.

This mode of reasoning will give to many of the mineral waters a much larger proportion of muriat of lime than they were ever suspected to contain; indeed sufficiently so as to increase the quantity to that medium dose of this substance which it would be prudent to prescribe. Muriat of lime has lately been found to possess very strong power on the living system, and is said to be a valuable remedy in scrophula and other diseases which are frequently removed by mineral waters. A few grains of this medicine will produce powerful effects, but it is not improbable that when a much smaller quantity is taken in a more dilute state, and combined with other salts, such as sulphat of soda or muriat of soda,

that its operation may by this means be rendered more active.

These observations more particularly apply to the more compound mineral waters, such as those of Cheltenham and Dunblane; but I dont see how the same reasoning is applicable to those containing fewer compound salts, such as the waters of Ballston and Saratoga, which we have found contain no sulphats, except it can be supposed that some part of that salt which appears to be muriat of soda may originally have existed in the water in the state of muriat of lime, or that part of the carbonat of lime which was collected was the product of close evaporation, and may have been originally in the state of muriat of lime.

Still the analysis has discovered muriats of lime and magnesia in both these waters, in sufficient quantity to have sensible effects on the system, especially when taken in so dilute a state and in such quantities as these waters are generally drank, and combined, as we find them, with other salts, as well as with important chalybeate qualities.

In order to form a more correct idea of the waters which are the subject of this essay, I shall take a view of the qualities of those mineral waters in Europe which are the most celebrated, and which have any resemblance to those which we have just examined; in doing this, I shall consult the latest and most esteemed authors on the subject; to which I shall add the result of my own observations and

experience, obtained from frequent visits to those places in Europe whose waters have the highest reputation and are most remarkable for their medical qualities.

However celebrated many of those waters in Europe are considered, when we examine their nature and properties and compare them with the waters of Ballston and Saratoga, we shall have reason to be convinced, that though these differ from every other in many respects, yet that they are superior to most and inferior to none of the most celebrated mineral waters of Europe. Annual visits to these watering places are now become so frequent and fashionable, that it is no unimportant circumstance to be acquainted with the virtue of those springs which are most frequented.

In Europe those places which at first were only frequented by invalids, are now become the resort of the gay and fashionable class of society, whose periodical visits are encouraged by the amusement and dissipation always to be found at such places. Such persons it is true, from excess of luxury and dissipation, are frequently affected with complaints for which many of these waters are necessary remedies.

In this country it is somewhat different, independent of that natural wish for change of air and exercise. The climate of this continent is so varied, that all degrees, from a West India to a northern temperature, is to be found in it.

Change, therefore, occasionally from one part of it

to another, becomes a matter of real necessity. The inhabitants of the south, whose constitutions are impaired from exposure to excessive heat and stagnant marshes, seek relief from both by visiting in summer those places where the purity of the air and the temperature of the weather afford them effectual relief. Those also whose occupations confine them to a residence in large cities, feel the same necessity; and providence has fortunately for such persons not only blessed them with such a climate in the middle states, but has there also provided them with such mineral waters, as of all others are best adapted to their complaints.

Without entering into any enquiry on the qualities of those mineral waters which have no resemblance to those of Ballston and Saratoga, I shall confine myself to a few of those which are more properly called saline, and shall divide them into simply saline, compound saline, and compound chalybeate and saline.

First, of simple saline waters. Of these we have two examples, Sedlitz in Germany, and Epsom in England. These springs contain, as their most active ingredient, and indeed almost their only one, a large proportion of neutral salts. This salt is principally sulphat of magnesia, with which Sedlitz is so highly charged that one quart of the water contains more than 350 grains of this salt. They neither contain carbonated earths, carbonated iron, or carbonic acid

gas; thus they are perfectly dissimilar to the waters of Ballston and Saratoga. They only agree in one respect, which is in containing a large quantity of a simple purgative salt, capable of being crystallized and taken with as much advantage any where else as at the spring; unimportant, therefore, as a mineral water in many respects, being totally deficient in many of the essential qualities to be found in the second class of compound mineral waters.

Of these, Seltzer water may be cited as a good example, as besides its saline contents it contains carbonated lime, carbonat of magnesia, and a large quantity of carbonic acid gas; it has, therefore, many principles in common with Ballston and Saratoga, but contains only 34 grains of marine salt, 8 grains of earths, and 34 cubic inches of gas in a wine quart of the water. In many respects, therefore, it is greatly inferior.

The waters of Vichy in France afford us another example of a compound saline mineral water, containing abundance of carbonic acid gas, both muriat of soda and sulphat of magnesia, the exact quantity of which I am not able to learn; but from the description given of its sensible qualities, it contains fewer ingredients, and those in less proportion than the waters of Ballston and Saratoga; it should also be observed, that this is a hot saline water, its temperature being 120, which materially alters some of its medicinal qualities.

The waters of Spa, in Germany, though they cannot be strictly called saline, yet in consequence of being highly impregnated with carbonic acid gas, require to be mentioned here. From the quantity of the gas which they contain, they appear highly acidulous; and containing nothing more than iron and carbonats of lime and magnesia, in small quantity, they have none of the valuable qualities attached to the Ballston and Saratoga waters. They are more pungent and more acidulous, because the gas which they contain is mostly uncombined, though they neither hold the same quantity of earths or gas, and scarcely any neutral salts; in consequence of which, they are principally tonic and stimulating,—qualities in many complaints of great importance;—and if to be found in any of the numerous springs at Saratoga, as is highly probable, would be of particular value, as the stimulating, and often astringent heating qualities which such waters possess, may be occasionally counteracted by the purgative effects of the Congress Spring.

The next water which I shall consider is that of Cheltenham, in England, as an example of a compound saline chalybeate and carbonated water. This water has been much celebrated in England, and with great justice. A comparison with the waters of Ballston and Saratoga, as given in the analysis, will show how materially they differ, and yet resembling each other in some of their most essential properties.

In the first place, Cheltenham water, though estimated as an acidulous and carbonated one, is greatly inferior in this valuable property to that of Ballston and Saratoga. Cheltenham is not estimated to contain more than 8 cubic inches of gas to the quart, while the latter hold from 60 to 65. Cheltenham contains of sulphat of soda and sulphat of magnesia 120 grains to the quart, while the waters of Ballston and Saratoga contain neither of these salts, but in lieu of these, are impregnated with from 43 to 105 grains of muriat of soda—a salt containing very sensible if not equal purgative powers. From experiments which I have made myself on the spot, I am satisfied that the quantity of oxyd of iron which the Cheltenham waters are said to contain, and which is estimated at $1\frac{1}{2}$ grains in the quart, is greatly overrated, as it is scarcely to be discerned by any test, and has never been collected in such quantity by evaporation.

Therefore it appears that Cheltenham, though possessing many valuable qualities in common with these waters, is inferior to either in the most important ones, its deficiency in carbonic acid gas being very apparent, and rendering it less tonic, less stimulating, and less agreeable to the palate, than the waters either of Ballston or Saratoga.

There is only one class more of mineral waters with which I shall compare those of this country; those are the mineral waters of Harrogate, in En-

gland. They are too celebrated to omit them, as furnishing us with an example of a very compound saline mineral water, which is more remarkable than any other in England, and more similar to those in this country, as containing principally the same kind of neutral salt, and nearly the same quantity of it. The difference, however, between both waters notwithstanding, is very essential; those of Harrogate, instead of containing the same quantity of carbonic acid gas simply, are impregnated with three different gases, viz. sulphurated hydrogen, carbonic acid gas, and azote; from the former of which, in particular, it derives some peculiar qualities. But its principal virtues arise from the quantity of muriat of soda and other salts and earths which it contains, rendering it a compound saline purgative, nauseous it is true, in the extreme, principally from the deficiency of carbonic acid gas, which contributes not only to the briskness and agreeable pungency of the waters of Ballston and Saratoga, but adds in other respects to its medicinal qualities.

Several of those mineral waters contain so large a proportion of neutral salts, that it has become an object of profit to collect them by evaporation and crystallization. This has been principally the case with respect to the waters of Cheltenham, where this business is prosecuted on an extensive scale, and for the sale of which article there is abundant demand, from the high character which these waters possess.

Until the real qualities of these waters were discovered, and it was found that they derived their principal value from sulphat of magnesia and sulphat of soda, assisted by a small proportion of carbonic acid gas and iron, it was not very surprising that many should imagine that these salts exclusively, possessed singular medicinal qualities. But that the practice of using them should still continue, is rather unaccountable, when we consider that by the process of boiling and evaporation, all the real qualities which these waters possessed, independent of their salts, are destroyed, and that a dose of those salts can have no other medicinal qualities than are possessed by the same neutral salts prepared in any other manner. These observations were called for, from having observed, while at Saratoga, that the salts from the Congress spring were collected in the same manner, and employed by many as a sovereign remedy, as a substitute in all cases where the waters were applicable.

If the practice of using those salts which are extracted from the waters of Cheltenham is in any degree absurd, how much more so is it when they are collected from the waters of Ballston or Saratoga? We have only to recollect the analysis of the Congress spring to perceive what a mixture of salts and earths must be collected from it by evaporation; and as those earths are no longer soluble when deprived of the menstruum which contributed to their solu-

tion, the carbonic acid, it will be easily seen what a strange and disgusting draught such a substance as the residuum of Congress water must make. To place this in the clearest light, we have only to mix 27½ grains of chalk, 17 grains of magnesia, about 110 grains of marine salt, and muriats of lime and magnesia, in a quart of water. So nauseous and unpalatable a draught would be received with disgust, and yet it is by no means dissimilar to the residuum obtained from the Congress spring by evaporation. There is one way of obtaining the salt in its crystallized state, so obvious that it is rather surprising it has not been adopted. This may be done by first boiling the water for half an hour. Nearly the whole of the earths will by this means deposit; after which, the water may be drawn off clear, and the salts alone obtained by evaporation.

To those who fancy that there is something in the salts of a mineral water which cannot be imitated by art, I would recommend this method, without being myself convinced that marine salt, obtained in this way, or sulphats of soda and magnesia obtained by crystallization from Cheltenham waters, can have any superior qualities than such salts obtained in the usual manner.

But there is no real necessity for this mode of collecting the salts. I have already observed that both the waters of Saratoga and Ballston retain so

much of their medical qualities when bottled, as to render the use of them even at a distance by no means ineffectual. This will be easily understood by a reference to the analysis. But it is not the case with respect to every species of mineral water, as there are many exceptions to it; for instance, the waters of Bath, in England, deriving as they do their principal virtue from their increased temperature more than from their foreign contents, should be drank exclusively at the fountain, in order to derive that benefit from them which may be expected from waters of such peculiar qualities.

The generality of chalybeates also do not retain their qualities for any length of time, so as to be of use at a distance from the well. The reason of this is obvious; the iron in those is held in solution by the carbonic acid gas, but the bond of union is very slight, and the slightest loss of this gas deprives the water of its iron, which is thrown down almost immediately after it is taken from the well.

As the preceding observations on the sensible and physical qualities of the waters of Ballston and Saratoga are intended as preliminary remarks to a more extended enquiry into their use and application to the cure of disease, I have endeavoured to render the subject more familiar to the generality of readers by comparing these springs with some of the most celebrated mineral waters in Europe.

None but those possessing strong sensible quali-

ties can be expected to have corresponding medical powers. I have, therefore, confined myself to observations on those only whose medical qualities are so apparent as to leave no doubt of their use as valuable remedies in the hands of a judicious and experienced physician.

A SYNOPTICAL TABLE,

Exhibiting the Contents of the Waters of Ballston and Saratoga, compared with others which they resemble.

NAMES of the WATERS.	Specific Gravity.	Cubic Inches.			Number of Grains in one quart of Water.								
		Carbonic acid gas.	Azotic gas.	Sulphurated hydrogen gas.	Muriat of soda.	Muriat of lime.	Muriat of magnesia.	Carbonat of lime.	Carbonat of magnesia.	Carbonat of iron.	Sulphat of magnesia.	Sulphat of soda.	Sulphat of lime.
Lowe's Well, Ballston.	1008	60½	2½		43	4¼	2¾	13½	7½	1			
Public Well, Ballston.	1008	61	2½		42	3¼	1¾	9¼	11¾	1			
Congress Spriog, Saratoga.	1012	66	2		103	3¼	4¾	27	17	½			
Flat Rock, Saratoga.	1007	66	1		41		4	15½	10¼	¼			
Sulphur Well, Harrogate.	1064	2	1¾	3¾	154	3¼	17	4¾	1¼		2½		
Crescent Water, Harrogate.	1002	5¼		3½	34		12¼			⅛	2		
Cheltenham, England.		7½	3½		1¼		6¼			1¼	80	40	10
Epsom, England.											120		
Seltzer, Germany.		45			34			6	5				
Spa, Germany.	1010	26			1½			2½	8	1			
Pyrmont, Germany.		56			3			9	20	1⅛			16

CHAPTER IV.

Containing Observations on the Medicinal Qualities of the Waters of Ballston and Saratoga, with plain directions for their use in a variety of diseases.

HAVING in the preceding pages given such an analysis of these waters as was necessary to form a correct judgment of their chemical properties, it now remains for me to make some observations on their medicinal qualities, and to describe those diseases in which they are beneficial, as well as those in which they are injurious. But as this would be of little value without a clear and correct knowledge of the mode of using them, I shall endeavour to point out the most judicious method of drinking those waters in all cases where they are applicable, with some remarks on the errors which at present prevail on this subject; to which I shall add such directions with respect to diet and regimen as may be necessary during the use of them.

When we take a view of the component parts of these waters as they appear by analysis, we must be satisfied that they possess several of the most active of those ingredients which are calculated to give medicinal properties to mineral waters in general. I am not inclined to attribute to mineral waters of any description any very exclusive property which cannot be shown by chemical analysis. Many of those to which

the vulgar are attracted by some supposed medical qualities, are, when we come to examine them, found perfectly inert; much, therefore, of the benefit which they are supposed to derive from them, may be easily accounted for from the influence of the imagination, as well as from other causes connected with the use of them at those often agreeable places. There are a certain class of people who run from one watering place to another in search of health, without any knowledge of the medicinal qualities of any of those springs which they frequent. It fortunately happens that most of them are innocent, and but few of them capable of doing any injury if drank in moderation. This is not the case, however, with respect to the waters of Ballston and Saratoga. I should conceive that they were of little value indeed, if they were not capable of doing great mischief; and I have seen sufficient of this from my own experience while there, to justify me in stating that from the quantities in which they are drank, and from the improper manner of drinking them, full as many have been injured as have received benefit from them; this, however, is one of the strongest proofs I can give of their valuable medicinal qualities. The most active poisons with which we are acquainted, when in the hands of a judicious physician, become useful medicines; but when in the hands of an ignorant empiric, they have most deleterious effects. The time is past when the operation of all mineral waters was so little understood, that no ex-

planation was attempted to be given of it; they were considered as specifics prepared by the hand of nature against those formidable diseases to which mankind were liable; they were only judged of by their effects and by the reports of those who had drank them. But at present we are in possession of the means which chemistry has afforded us, to learn with the utmost accuracy what are the ingredients of any mineral water; whether they are active, or inert. We now know that every mineral water is a compound of the water itself and of those substances which give it sensible properties, the water being only the menstruum which conveys those substances into the system; but I am not prepared to deny that this vehicle does not add something to their effects; on the contrary, I am convinced that there is no other way of accounting for the very powerful effects of many of those springs but by attributing much of it to the quantity of this liquid which is taken with it into the system.

I shall now consider the principal qualities of the waters we are treating of. A reference to the analysis will at once show that they contain a considerable quantity of carbonic acid gas, both combined and uncombined, or in a free state; next, that they all contain a large quantity of a neutral purging salt, the muriat of soda; but that in this respect some of them contain more than others, a circumstance extremely fortunate, rendering them more generally

useful, suitable for different diseases and different constitutions.

They are next found impregnated with oxyd of iron in sufficient quantity, and in that peculiar state which renders it most efficacious as a medicine. It appears also that some of the springs are highly impregnated with it, while others scarcely contain any.

Besides those substances which I have mentioned, and which certainly are its most active and useful ingredients, carbonats of lime and magnesia in considerable quantity, and muriats of lime and magnesia in small quantity, have been discovered in them. I shall now, therefore, proceed to consider the medicinal qualities of each of those substances, either uncombined or in that state of combination, which we find them in the water.

The first ingredient in these waters which requires notice is the fixed air or carbonic acid gas; this is so very important a one, that upon it, it may be said, the principal qualities of the water depend; all other ingredients which it contain would be heavy and inert without the aid of this acid. Deprive the water of this principle, and almost all its virtues disappear; it is this which holds the iron and earths in solution; it is this which gives that agreeable pungent subacid taste to the water; and it is also this gas that produces that exhilaration of spirits which almost all persons feel who drink the water. Pure water highly impregnated with this gas alone,

has been found to possess medicinal qualities. It communicates to the waters an antiseptic, stimulating, and frequently a diuretic quality; but when combined with such substances as we find in these waters, it not only retains the same qualities but it contributes greatly to the value of all the rest. Thus waters, which contain large quantities of a neutral salt, would be so nauseous without this gas that few would persist in the use of them; besides, from their stimulating effect on the stomach, the debility produced by the use of those salts is in some degree counteracted.

The next useful substance contained in those waters is the muriat of soda or common salt. It is most certainly from this salt, combined with the water in a very dilute state, that the purgative quality of these waters are principally derived. The generality of saline mineral waters contain a combination of neutral salts, from all of which nothing more can be obtained than from one simple purgative salt. It is a matter of doubt with some, which of those salts are the most valuable; provided, however, that they produce the same effect, there is but little difference. I am aware that there are but few who suspect that the waters of Ballston merely contain common salt as a purgative; and there are many who would be but little inclined to credit it. There must be something peculiar or mysterious in the quality of any medicine to induce a certain class of patients to place confidence in it. Deprive medicine

of all its mystery, and you deprive it of a valuable auxiliary. This may appear rather a candid acknowledgment for a physician, yet I am no less persuaded of the truth of it; though I am ready to allow that it is too often made use of to conceal real ignorance. How few patients are there who can be trusted with the secret of their own complaints, or the knowledge of those medicines which the Physician has frequently to prescribe for them. None but those who have studied with attention the human mind, can judge of the powerful influence of the imagination in the cure of diseases. Confidence in a physician produces confidence in his prescriptions; thus the imagination co-operating with the effect of the medicine, the physician practises without embarrassment, and the patient receives the full benefit arising from it.

That a substance with which we are so familiar and which is almost a necessary of life, should be a very powerful remedy, does not at once strike every person. But combined as this salt is, in this water, with other substances, its sensible and even physical properties are greatly altered and improved, so much so that few of them are attributed to the substances which they really contain.

The effect of muriat of soda or common salt on the system, is nearly the same as any other neutral salt. It almost always proves purgative; it is more stimulating to the stomach and bowels than most other salts; and the use of it, for this reason, should

be confined to small quantities, by which means it may be persevered in for a much greater length of time than most others.

But it must be obvious how much its qualities must be improved in this way by its combination with an excess of carbonic acid, so that daily evacuations from the bowels may be produced without debilitating either the stomach or intestines, or impairing the digestive powers; but on the contrary, the appetite, spirits, and general health, will be frequently improved by the use of these waters. There are few constitutions that cannot bear it in small quantity; but some judgment is required in the use of it, which should be always regulated by its effects.

It has been observed in the analysis, that the waters of Ballston and Saratoga differ from each other extremely in the quantity of salts which they contain; there are, therefore, some diseases in which the waters of Ballston may be highly useful, when the waters of the Congress spring may be extremely injurious. In other cases the Congress spring, from its superior purgative quality, may afford greater advantage. It shall be my business, when speaking of particular diseases, to point out this.

It is not from its saline contents alone that the effects of these waters should be judged; it is from the combination of several substances in the aggregate as we find them combined in the water, that we must take advantage. Hence this water may be used

as a powerful evacuant as well as a gentle alterative. At present, therefore, I shall only say, that in all diseases requiring a mild and stimulating purgative, possessing at the same time tonic and deobstruent qualities, great advantage will be found from the use of these waters.

The next ingredient in some of those springs which I shall consider, is the iron with which they are impregnated. Small as this appears to be, it is equal to any of the most celebrated waters in Germany or in England, and experience has shown us that the use of it is attended with the best effects. The effects of iron upon the animal economy are very numerous; it stimulates the fibres of the stomach and other abdominal viscera, increases the tone of the muscular fibre, and gives the whole system remarkable energy and vigour. In all cases, therefore, of laxity and debility, and in obstructions proceeding from these causes, iron is an admirable remedy. In all the various forms in which it has been given, there is none in which more benefit has been obtained from it, than when taken into the system in the state of an oxyd, and in small quantities. In this state it is found in the waters of Ballston, suspended by the carbonic acid gas, a very powerful remedy in itself and a most useful auxiliary in all those complaints where iron is found useful. Hence chalybeates have been long considered as one of our valuable remedies, owing to the manner in which the iron is held in solution. In almost any other form

that the physician can administer it, some inconvenience attends the use of it; hence Dr. Cullen observes,—"Mineral waters often produce cures which we in vain attempt to perform by the combinations in our shops, even although these waters contain nothing but iron." How much more valuable, then, must these waters be if this is the case, where besides the iron we find other very powerful ingredients. The extreme quantity of carbonic acid which we find in them is a valuable addition. The muriat of soda which constitutes it an active saline chalybeate, is also of service when not pushed too far. In the springs at Ballston in particular, the salts are scarcely more than sufficient to counteract the astringent effect of the iron without interfering with its tonic qualities; on the contrary, by its acting as a gentle stimulus to the nerves of the stomach, it may promote appetite and digestion.

There are only a few other substances with which these waters are impregnated which require notice. Muriat of lime, if found in sufficient quantity, must, from our experience of its effects in scrophula and glandular obstructions, be considered a useful substance. I confess that I have not found it in sufficient quantity for much stress to be laid on it; and unless the opinions of Dr. Murray are well founded, and that it should appear hereafter that those waters contain more of muriat of lime than has been the product of evaporation, I am not disposed to assert that much advantage arises either from the quantity

of muriat of lime or muriat of magnesia, which any of the springs contain.

There are very few waters that have as yet been examined, that are found to contain such a quantity of carbonats of lime and magnesia. The Congress spring in particular contains 44½ grains in a quart of the water. It becomes a question therefore to enquire whether any benefit arises from this substance, or whether it becomes injurious when taken into the system in such large quantities as many persons must do, who drink so profusely of this water.

Chalk, or what is the same thing, carbonat of lime, has always been considered by physicians as a useful medicine; and in diseases of the stomach and bowels, where a tendency to acidity prevails, has been given with success; when combined with an acid it has not, like magnesia, a purgative quality, but rather the contrary; much of it may be taken into the stomach without having any remarkable effect; therefore it certainly may be useful in that state of the stomach tending to acidity, which prevails in certain cases of dyspepsia, and its astringent effect will be counteracted by the quantity of neutral salts which accompany it. Bergman, in his instructions for making artificial mineral waters, recommends that on all occasions the calcarious matter should be left out, from an opinion that they are more than of a suspicious character, and do not contribute to the salubrity of the water.

It has been also asserted, that the principal cause

of all those tumours in the neck which are called Bronchocele, to which the inhabitants of the Alps and of Derbyshire are subject, arise from the hardness of the waters or from the quantity of lime with which they are impregnated. However, none of the waters in those places contain such a quantity of earths as the waters of Ballston or Saratoga; and yet I never heard of a person in that district who was affected with that complaint, although the children use this water and prefer it for their common drink.

One cause that has been assigned for this disease cannot, therefore, be correct; and I am disposed, on the whole, to conclude, that there are causes in which these carbonats may be of use, and none in which they can be injurious.

Having thus taken a general view of the medicinal qualities of these waters, I shall, in the next place, point out those particular diseases to which they are applicable.

The first class of diseases which are peculiarly benefited by the use of these springs, are those which proceed from a disordered state of the functions of the alimentary canal, or from obstructions of any of the viscera, particularly of the biliary organs, whether occasioned by irregularity in living, or the vicissitudes of climates or seasons. This comprehends a great variety of diseases, which are generally and fashionably called Bilious.

In almost every case of this kind, great relief will be found by the use of these waters; but particularly

in those chronic cases of long standing which succeed an inflammatory attack of the liver, and produce a disorganized state of that viscus, causing either an excess or a deficiency of bile, or an irregularity of its secretion.

The most effectual means of resolving or removing such obstructions is obviously by the intestinal canal; and if there is any one remedy more suitable than another for this purpose, it should certainly be that which is capable of exciting a discharge from the bowels for any length of time, without endangering the constitution or producing any great debility. Such effects may be expected from the waters of Ballston or Saratoga, provided they are used with caution and judgment.

After the description which I have already given of those waters, it will be perfectly understood in what qualities they differ; and therefore under what circumstances a choice of either of them should be made. Where diseases of the biliary ducts or intestinal canal are produced rather by an excess than a deficiency of bile, and are attended with an increased discharge rather than a constipated state of the bowels, it will readily occur that recourse should be had to the waters of Ballston; but as it is more frequently the case, that the action of the bowels in this complaint is not only sluggish, but irregular; and as costiveness is a prevailing symptom, more benefit may be expected from the waters of the Congress Spring at Saratoga, which is much more powerful as a

cathartic; and may, with proper management, be made to promote a regular discharge from the bowels as long as the case requires it.

On this part of the subject, where I conceive so little judgment and discretion is used, I hope I may be permitted to state my opinion.

Whatever benefit may be expected from any of those waters, can only be obtained by drinking them in such quantities and at such times as the experience of a physician may point out. The regulations which are thought necessary and are adopted in other countries during the use of a mineral water, are either unknown or neglected here. There seems to be no guide to the use of them, but that which is the natural guide of all animals, which is to drink till the stomach is satiated. As little attention is paid to the time of drinking those waters: they are used at all hours by most persons,—as often in the evening as the morning,—under an impression that no injury can be produced by them, and that the greater the quantity, the greater the benefit.

It may appear rather incredible to some, but it is no less true, that by this mode of practice the stomach has been brought to bear such a quantity of this water, as would be thought to exceed its usual dimensions. I have known more than one instance where a person has drank seventy-five half pint tumblers in the course of one day; and as nearly as I could discover, I found few persons who were satisfied with less than ten tumblers three times

a-day, as the use of it is as frequent in the evening as in the morning.

That serious injury arises from this extravagant use of the water cannot be doubted. There are two principal causes from whence it arises: the first is an opinion that no possible benefit can be received from the use of a mineral water unless the effect is obvious and immediate; the next is, that few who frequent this place can afford that leisure from business which is necessary to remain sufficiently long to obtain real and permanent benefit from a course of them. The consequence is, as I have been more than once informed, that such persons think they should take every advantage of their short stay, and drink as much of the water as possible.

From this strange and incautious mode of drinking them, serious injury arises. Many of those who would otherwise receive the relief which they sought for, find in some instances an aggravation of their complaints, while others receive no effectual benefit. The natural consequence is, that the reputation of such waters is diminished; when the whole arises from the improper use of them.

It will, I presume, be readily allowed, that as it requires a certain degree of experience to form a skilful physician, so is it equally essential to have a correct knowledge of the medicines which he prescribes, whether it is in the form of a mineral water or any other. If the test of experience is thus to be relied upon, we must look for information to those

whose extensive practice at those places which are most celebrated in Europe, has taught them the most judicious application of mineral waters to a variety of diseases. From consulting the best authors on this subject, and from my own experience, I am prepared to say that the practice of other countries with respect to the mode of making use of mineral waters, differs essentially from the general custom adopted in these states. And unless some more satisfactory explanation can be given than that which I have usually heard, I cannot be persuaded but the general practice of this country is not the most judicious. Great stress has been laid on difference of climate and difference of constitution: even this is by no means satisfactory. The human constitution does not differ so extremely in two different countries nearly under the same latitude, as totally to change the practice of medicine. That some diseases are more frequent here than in Europe, will be allowed; that others put on a different type, and require somewhat of a different treatment, may also be granted; but that the same diseases which are relieved and often cured by a certain mode of drinking the mineral waters in Europe, should require so very opposite a plan here, cannot be so readily granted, without much more experience than has yet been obtained in this country.

To lay down particular rules for the general use of these or any other waters, would require a much more extensive discussion of the various diseases in

which they are useful, than would be expedient in a treatise of this nature.

I shall, therefore, principally confine myself to the most eligible course to be pursued by invalids who have recourse to those waters for their health; remarking particularly on the cautions to be observed by those who, without advice or reflection, so copiously make use of these fountains.

It will be readily understood that the use of these waters should be chiefly confined to those chronic cases of disease where all traces of active inflammation have subsided, such as complaints of the biliary organs, of the alimentary canal, or any of the viscera, arising principally, as I have before observed, either from intemperance or from climate, and frequently accompanied with jaundice. These are a class of diseases for which such waters as Ballston or Saratoga have been considered a sort of specific; and I think I may venture to assert, that there are few such patients who would not be effectually relieved by the use of them. The first circumstance to be attended to is the choice of the spring, as much more depends upon this than the generality of persons are aware of; indeed so much, that if possible it should always be regulated by the advice of a physician on the spot. Whatever confidence a person may place in their family physician at home, it must be evident that he is not always the best qualified to advise under all the variety of effects which may be produced by the use of a mineral water, the qualities of

which he cannot be supposed to be entirely acquainted with. More instances than one have I observed of the injury which has been produced by a pertinacious adherence to the advice of a family physician, which he had kindly furnished his patient with in writing for his guidance at a distance; and who, without detracting in any respect from his merit as a physician, was most probably totally unacquainted with the nature and effects of those waters which he prescribed.

In all those complaints of the biliary organs which I have here referred to, it will be most judicious to commence with the water of the Congress Spring; particularly if there are any symptoms of obstruction in the biliary ducts, attended with jaundice. In such cases there is generally a tendency to costiveness, and as this water contains sufficient salts to render it a mild purgative, it should obviously be preferred. With respect to the quantity which should be taken, much of this depends upon the constitution of the patient and the first effect of the water. One certain rule, however, may be laid down, which is, that its good effects will depend upon the regular discharge which it produces from the bowels, without weakening the tone of the stomach, or producing debility; and if some such effect as this is not produced in a short time, recourse must be had to some more active remedy.

Patients who commence a course of these waters, should begin with drinking one or two half pint

tumblers early in the morning, about an hour or two before breakfast, and at intervals of a few minutes, using a little exercise between each glass. If these have no effect, a third, or perhaps a fourth, may be drank; but if these should produce no effect on the bowels, nor act as a diuretic, the stomach will become distended, headache and giddiness will probably supervene, the appetite will be impaired, and the whole system disturbed. In this case it is not only useless, but dangerous, to persevere, as increasing the dose will only aggravate these unpleasant symptoms. It may, however, be again drank in the same manner about an hour or two before dinner; when, if the same symptoms are produced, recourse must be had to other remedies.

Perhaps one of the best modes of practice in such a case would be, to take a few grains of the pil. aloet. comp. combined with a small quantity of calomel, at bedtime, commencing next morning with a few glasses of the water; by this means the bowels will be excited to action, and less of the water will be required. All those symptoms, arising from repletion, which were brought on by such a quantity of the mineral water, will then disappear; an agreeable sensation will be produced in the stomach by the use of it, and exhilaration of spirits and increase of appetite will be the natural consequence.

The use of this water may be continued in this manner for a considerable time without any debilitating effect; and after a few weeks, recourse may

be had to the waters of Ballston, which are not so purgative, and as containing more iron are more tonic, and more capable of restoring the tone of the system, while they still possess sufficient salts to counteract any astringent quality which it may possess.

So much injury arises from the enormous quantity of this water which many think it necessary to drink in order to produce a cathartic effect, that other expedients may be suggested besides that which has already been mentioned. At Cheltenham it is not unusual to add a little of a strong solution of the crystallized salt to the water on those occasions. This is by no means injudicious, particularly as you add the same kind of salt with which the water itself is impregnated, and as it is always effectual in its operation. I have made use occasionally of the same practice at Ballston, and with the same success, but always recollecting that it should be a neutral salt which is not capable of decomposing the muriat of soda; in this manner the phosphat of soda, which is an effectual and agreeable purgative, may be added to the water. Two or three drachms of it previously dissolved in a little soft water, may be added to a glass of Ballston water fresh from the spring, without any decomposition taking place, and with a manifest increase of its purgative quality, whenever it is required.

Something of this kind should always be recommended, rather than increase the dose of the water to

such a degree as, from the quantity of carbonic acid which it contains, as well as its alkaline earths, can never be drank in such a manner with impunity.

Had I not been witness to the custom of drinking those waters at very unusual hours, particularly in the evening, I should scarcely think it necessary to say any thing on this subject; but finding that this practice is general here, and that the springs are as much frequented from dinner till bedtime as in the morning, I cannot omit making a few observations on so injudicious a practice.

I have searched in vain for any author who has recommended it; and from every thing which I have learned, and every thing I have observed myself at other places, I can venture with confidence to say, that there are very few instances indeed where the waters should be taken in the evening.

In Germany, where most attention is paid to this subject, and where the use of mineral waters should be well understood, no such practice as this prevails; and of so much consequence is it thought to make use of such waters with caution and judgment, that the practice is in some degree regulated by the government, who appoint a physician to attend for that purpose. At Cheltenham in England the practice of drinking the water late in the evening has so little prevailed, that the well is regularly closed at two o'clock, and no access to it allowed till six the next morning.

If a mineral water is possessed of any powerful

medicinal qualities, (and that the waters I treat of are possessed of them cannot be doubted) then it must be allowed that the use of them should be regulated by the same rules that are practised with respect to all medicines whatsoever.

Those waters are chiefly useful when their purgative operation is gentle and regular; they should, therefore, be taken in sufficient quantity to produce this effect, and not at very long intervals; and when this effect is produced, time should be given the stomach and bowels to recover their tone, which would be greatly impaired by too frequent a repetition of the dose of the water. Such would be the plan that a physician would naturally pursue when advising a medicine. When, therefore, the operation of the water during the morning has been sufficiently apparent, there is no farther necessity for it during the rest of the evening, and more particularly after a full meal. It is, I am convinced, in consequence of the prevalence of this practice, that fewer persons are relieved than we usually hear of at Ballston.

By a proper attention to these observations, a course of these waters in such complaints as I have here recommended them, may be pursued for four or five weeks without palling the appetite or injuring the digestive powers, which too frequent and habitual a use of them will naturally produce. Dr. Fothergill, whose experience on such subjects may be relied upon, when speaking of the virtues of the waters of Cheltenham, makes similar remarks, and

farther observes, that the use of them should be occasionally even suspended for a day in each week, in order to give the system a proper respite, and to prevent the water losing part of its efficacy through habit. It ought also to be left off in the same gradual manner that it was begun, using for the space of two or three weeks after it a more abstemious diet, and guarding against costiveness.

Persons affected with such diseases as I have described, should pay particular attention to diet and regimen; those who are liable to frequent returns of biliary attacks, should live temperately, avoiding all unwholesome food and meats which are not easy of digestion; all kinds of fermented liquors are improper; and as intemperance, particularly in the use of spirituous liquors, is too frequently an exciting cause of those complaints which arise from affections of the liver, persons who feel any predisposition to such a disease, should guard with the utmost care against the baneful use of spirits under any form.

At dinner all the lighter kinds of meat roasted, such as veal, lamb, or chickens, may be made use of, but vegetables very sparingly; and if fruits are permitted, they should be such as are perfectly ripe, such as strawberries and gooseberries. In those cases most particularly where the water affects the bowels rather freely, and where there is no suspicion of an inflammatory affection, a few glasses of good wine may be always taken after dinner with manifest advantage. This will contribute to support the tone

of the system; and when assisted by social and agreeable conversation, it tends to amuse the mind and restore the spirits,—circumstances of no small importance to all persons labouring under chronic complaints, who expect to reap permanent benefit from these waters or any course of medicine.

The same cautions should be made use of with respect to breakfast as have been given with respect to dinner, particularly as in this country breakfast is a meal where the appetite is unnecessarily indulged. Besides the usual beverage of tea and coffee, meats of all kind both fried and broiled, and fish both salt and fresh and in a variety of forms, are introduced. I should be rather inclined to give an opinion that even in the best health such an indulgence, to say the least of it, is unnecessary; and certainly it is attended with no apparent advantage, as it is manifest that those who accustom themselves to such breakfasts are neither stouter nor healthier than those who live differently. Custom, however, reconciles this diet to those who are used to it; and after long habit, it would be a difficult matter to persuade some persons here that a breakfast, which was not principally made up of salt fish and beef steaks, could be nutricious.

But there are other objections of rather a serious nature to such breakfasts, particularly while under a course of mineral waters. Salt fish and salt meat when taken at breakfast have a natural tendency to produce thirst in the course of the morning; to re-

lieve which, recourse must be had to some liquid drink. It would be well under such circumstances if nothing more injurious than water was usually taken; but it is very much to be feared that this is not always the case, and that by degrees a habit is acquired of making use of spirits in addition, and thus a custom of drinking in the morning may be induced, not more prejudicial to the morals than injurious to the constitution.

To those, therefore, who have no complaints except, perhaps, what this mode of diet occasionally induces, I shall venture to make no appeal; but I may be allowed to remark, that, upon every principle of medicine, those who are commencing a course of these waters should be satisfied with lighter breakfasts than are generally used. Neither salt meat nor salt fish should ever be allowed. If any sort of fresh meat should be permitted, it should be that which is very light and either cold or broiled, avoiding in particular that which is either fried or stewed with much butter, as is the common practice. But the usual light breakfast, consisting of tea or coffee with toast and an egg slightly boiled, is much to be preferred during a course of these waters; and particularly as it is taken in so short a period after the water has been drank at the fountain.

In addition to these rules in regard to diet and regimen, I shall not omit to inculcate exercise; as of all the various methods of preserving health and preventing diseases which nature has suggested, per-

haps there is none more efficacious than attention to exercise. It contributes to the circulation of the fluids, it strengthens the solids, and promotes perspiration. Without exercise, particularly in that class of diseases which are usually called nervous, neither medicine or mineral water will have much effect. Let those, therefore, who frequent such places for the benefit of their health, take as much exercise in the open air as they conveniently can. When patients are weak or have been accustomed to a sedentary life, their exercise should at first be gentle, and on horseback or in a carriage, and gradually increased until their strength can bear the exercise of walking; but in general the exercise of riding should be preferred, as it is not attended with the fatigue of walking, and the free air in this way is rather more enjoyed. The best time for exercise when the weather permits is between breakfast and dinner, as the body is then more vigorous and alert, and the mind more cheerful; the appetite is by this means promoted, and the stomach enabled to perform its functions properly.

Exercise after a full meal can never be wholesome; it disturbs digestion, and causes painful sensations in the stomach and bowels, with acid eructations. For this reason it will be improper for invalids to take exercise immediately after dinner, before the process of digestion has been in any degree performed. The instinct of all animals lead us to this conclusion, as even the beasts of the field instinctively rest them-

selves when the stomach is full. It is certainly too much the custom here to rise immediately from table and proceed at once to business of some kind or other; and it may be suspected that some of those diseases of the stomach with which so many are afflicted, are, if not originally induced, materially aggravated by this practice. A moment's reflection will satisfy any person that both the mind and the body should be left for some time after meals to cheerfulness and rest. Hurrying out from a full meal and a warm room into a frigid or a torrid atmosphere, to intense study or to a calculating counting room, is not the best adapted to preserve health or to relieve disease.

For the cure of dyspepsia the waters of Ballston have been long celebrated, and the great majority of the visiters are persons who consider themselves as affected with this complaint. I am by no means disposed to deny that this is not a very frequent and common disease in this country, or that in many instances the waters of Ballston may not be used with advantage; but I have had many reasons to convince me that this name is often given to diseases of a very different character. Whenever the system is disturbed, and that the appetite and digestion are impaired, a variety of anomalous symptoms are produced, attended with a certain anxiety of mind which it is difficult always to account for; but to which, however perplexed may be the physician, it is always expected he must give some name. Under these cir-

cumstances, perhaps the name of dyspepsia is as convenient as any other, particularly as it is a fashionable one, and conveys no alarm to the patient. Dyspepsia is not in general a dangerous disease; it seldom proves fatal except when it continues so long as to produce great general debility. A long train of symptoms usually attend this disease, such as loss of appetite, nausea, vomiting, heartburn, flatulency, and acid eructations, irregularity in the discharge from the bowels, and frequently obstinate costiveness.

These symptoms seldom appear till the middle period of life, and are generally induced by irregularity of life, intense application to business or study, exposure to vicissitudes of weather, and want of accustomed exercise; to which I may add, as more peculiar to this country, the excessive use of tobacco in every form, particularly that of smoking or chewing, both of which excite the salivary glands to action, and produce that disgusting and common practice of spitting, a practice than which, perhaps, there is none more injurious to the progress of digestion, or so liable to induce dyspepsia. It deprives the stomach of part of its gastric juice, and brings on a variety of nervous symptoms, attended with loss of appetite, general emaciation, and debility.

These are the symptoms of genuine dyspepsia; and for the cure of which disease, I know of no better remedy than the waters of Ballston. But much attention should be given to the use of them; and as

the disease is one of debility, it can only be effectually relieved by whatever tends to strengthen and invigorate the tone of the stomach. Chalybeates, therefore, have been long celebrated for the cure of this complaint; they have been, however, recommended too indiscriminately, under an erroneous impression that all mineral waters are nearly the same. In trivial cases a simple chalybeate, when persevered in for a length of time, has been known to alleviate many of the symptoms. But it will be recollected, however, that Ballston water is not a simple chalybeate, but that as it possesses other very powerful ingredients, it is greatly to be preferred to every other. The Congress Spring is not so well calculated for the cure of dyspepsia, and should never be had recourse to in this disorder except in those cases where obstinate costiveness in an urgent symptom.

The same rules which I have already suggested for the use of this water should be attended to here, but even with more caution, as it is from its tonic qualities that its principal benefit is derived. It should therefore be drank rather sparingly, never in such a quantity as to act powerfully as a cathartic, which would only increase the debility. The diet should be more free and generous than in other complaints, and a moderate use of wine may be allowed where it does not become acid on the stomach; otherwise weak brandy and water may be substituted.

I have found an idea prevailing at Ballston that

wine should never be permitted during a course of these waters, as it has been frequently asserted that this water and wine do not assimilate in the stomach. From whence this opinion proceeds, I confess myself ignorant; or while so little attention is paid to the quantity and quality of the food that is taken into the stomach, so great an objection should arise to the smallest quantity of wine. Let it be recollected that the cases in which these waters are principally beneficial, are cases of debility; and that though the waters if properly used would act as a tonic, yet in most cases they are drank in such quantities as to produce a contrary effect. It can scarcely, therefore, be doubted but to counteract the debility thus induced, a few glasses of wine may be safely permitted after dinner. All writers whom I have ever consulted agree in this matter. The names of Saunders, Smith, Fothergill, and Garnett, are sufficient if there could be any doubt on the subject.

The advantages of air and exercise admirably coincide with the curative effect of those springs. The mind is to be amused at the same time that the body is employed; and as there is often such a depression of spirits as borders on hypochondriasm, all occupations of business which produce either care or anxiety should be studiously avoided, while the mind should be diverted to other objects. Hence is it that such places of public resort, where cheerfulness and society are always to be found, are very justly ob-

served to co-operate so much with the medicinal qualities of the mineral water.

The above observations are intended to apply to cases of genuine dyspepsia; but so many have frequented these waters, particularly from the northern states, who are persuaded that they labour under this complaint, and therefore have erroneous views of the mode of cure, that though I am inclined to fear that I differ from the faculty in that place, yet I cannot dismiss the subject without stating the grounds of my opinion.

In Boston in particular, of late years a disorder has prevailed to which the faculty have given the name of dyspepsia; to doubt the propriety of which, would seem to be an instance of some presumption. As far as my observations have gone, a complaint somewhat similar is there a very frequent disease. It principally makes its attacks at a very early period of life, reducing the patient to the utmost state of emaciation and debility: many of the symptoms are such as are usually observed in dyspepsia; they are continued for a length of time, and are aggravated in the winter months. Children of the age of ten or twelve years are not exempted from it, and some of the finest young men in the country are attacked with it from the age of fifteen to twenty-one. It soon reduces the patient to a state of the utmost debility and emaciation, such as is usual in the last stage of phthisis pulmonalis; the countenance is altered, the cheeks are prominent, the eyes look hollow and languid,

the hair often falls off, the nails are of a livid colour, and the pulse becomes so low that I have in one instance been able to count only forty-five strokes in a minute. The persons most liable to this complaint are remarkable for a particular formation; a long neck, prominent shoulders, narrow chest, clear skin, and thick upper lip, with other marks of a scrophulous diathesis. They have no cough, nor can any suspicion be entertained of an affection of the lungs during the whole of the disease. If I am correct in those appearances, have we not much ground for suspicion that there is a scrophulous disposition in the system, and that the whole of those symptoms arise from an obstruction in some of the lymphatic glands in the neighbourhood of the stomach, or in those of the mesentery, similar to incipient tubercles of the lungs, and rendering them incapable of conveying chyle or nourishment to the system; thus arises that emaciation which constitutes a species of marasmus, and is so similar to that which occurs in the latter stage of consumption.

However unpromising those appearances are, yet as in scrophula, such cases seldom end fatally. The disease continues for a few years till the body attains full growth and strength; it then gradually disappears, and perfect health is at last restored. I know of one instance at present in a young female where all those symptoms run their course, but who is now restored to health and animation; and I could state others who, under the most discouraging symptoms

and at the period of life when scrophula usually disappears, have equally recovered.

A few reflections now arise out of such cases, in order to prove that they cannot be considered as cases of genuine dyspepsia.

First, the attack does not commence at that period of life that dyspepsia usually does. Dyspepsia is a disease of the middle aged; scrophula, of the young. Secondly, dyspepsia is the disease rather of warm climates, and is relieved by change to a cooler one; scrophula is the disease of a cold climate such as the eastern states, and the symptoms are always aggravated in the winter months and relieved in the summer; so much is this even acknowledged in the eastern states, that persons who are affected with this complaint, there denominated dyspepsia, are always benefited by change in the winter to a warmer climate.

The exciting causes also of dyspepsia are as different as possible from that of scrophula. In the mind of the one there is a gloomy anxiety and predisposition to melancholy, while those who are predisposed to the other are youths of animated dispositions, superior intellects, and refined sensibility.

The practical inferences which may be drawn from the above are, that if such are the symptoms of this complaint, it should be considered as connected with a scrophulous taint at least, and arising from a diseased state of those glands which are situated in the neighbourhood of the viscera.

Of all remedies, therefore, which I am acquainted with, I should with confidence recommend such mineral waters as Ballston and Saratoga: But if it is expected that a cure is to be performed by very large doses of either of them in a few days, the patient will be grievously disappointed; on the contrary, it is only by a regular perseverance for the greater part of the summer that any benefit can be expected; and though the terms alterative and deobstruent are almost exploded from medicine, yet I am not altogether disinclined to think that they contain some meaning, and that in cases where the lymphatic glands are obstructed such waters have what have been called deobstruent qualities.

One season at these waters will not always be sufficient, in a complaint which has been known to last for years before it disappears.

With respect to the use of a bath, I am disposed greatly to prefer that of the hot to a cold bath for very obvious reasons, and also that the bath should be frequently used and of a high temperature. In cases of scrophula which break out on the surface of the body, I am aware that the cold bath is preferred, but in such cases the general health is not so impaired, and there is no great debility; but in the complaint which I treat of, where the organs of the stomach and bowels are the seat of the disease, and where there is so much general debility, there may be some danger that there is not sufficient reaction

in the system to render the use of the cold bath either a safe or a useful remedy.

Whenever it is practicable after the season of drinking the water is over, it would be highly advisable to remove for the winter months to a warmer climate. By such a change great benefit will be derived, and a relapse during the winter prevented. The same cautions which I have given in genuine dyspepsia, may be repeated here. The water should be drank in moderation only before breakfast and between breakfast and dinner. Ballston water should be principally relied upon, though occasionally to open the bowels, that of the Congress Spring may be used. The diet should rather be full and generous, and the use of a moderate quantity of wine may be permitted.

I proceed now, as connected with this subject, to the use of these waters in scrophula in general, exhibiting itself in the usual form externally. This is a complaint of so peculiar a character, that however unwilling many are to acknowledge any disposition towards it, yet few can mistake its appearance.

For this disorder unfortunately we have no certain cure or specific; it generally runs its course, but many of its most disagreeable effects may be arrested by proper care and attention in the first stages of it.

One of those remedies which have been found most useful, has been sea water used externally and internally. Plentiful dilution of this water, on account

of the saline matter which it contains, has been recommended as one of the most useful remedies. But whatever encomiums it may merit, all these good effects may be obtained from the saline waters of either Ballston or Saratoga. They may be used in sufficient quantity to act moderately only on the bowels, for since scrophula is generally accompanied with a debilitated state of the system, purging will be improper; besides, it prevents the water from entering the blood. Ballston spring is, therefore, best calculated for scrophulous complaints, since the portion of salt which it contains is just sufficient to make it act as a gentle stimulus upon the excretories, without causing it to operate too powerfully on the intestines. By this means it will be taken into the blood, enter into the most minute vessels of the body, and promote all the secretions, while the iron which it contains will tend to remove the debility, which, if not originally the cause of the disease, always retards its cure.

With the same intention a cold bath may be used, if there is not too great a debility to render it hazardous; and if any scrophulous swellings or ulcers are present, cloths kept continually wet with the same water may be applied to those tumours. The bath which should be preferred is that from the Congress Spring, as being more saline and coming nearer to sea water. To add to the tonic effect of this water, the patient should make use of a light, nutritive, and generous diet; he should breathe a pure dry

air, make frequent use of the flesh brush, and take moderate exercise daily.

While I am on the subject of the use of these waters in particular complaints, it may be thought an omission should I pass without observation the effect which may be expected from them in the diseases of females. However much these complaints have engaged my attention in the course of my practice, yet I am aware that in a work which is not altogether professedly medical, this subject should, for very obvious reasons of delicacy, be but incidentally touched on; to pass it by altogether, would, however, be to omit one of the most valuable qualities of these waters. From long experience I have the most decided conviction that the origin of all female complaints may be traced to debility; and whether arising from obstructions, or the contrary, they may be ranked under that class of diseases which depend upon relaxation, and which can only be effectually relieved by tonic medicines. Those who suffer most under these complaints are affected with the usual symptoms of debility, such as paleness of the countenance, inclination to syncope, palpitation of the heart, loss of appetite and various other symptoms of dyspepsia, sluggishness, lassitude, and headache, followed frequently by œdematous swellings of the feet. These, it must be allowed, are all symptoms of debility; and if I know of any one remedy more capable than another to remove such complaints, I should say such mineral waters as Ball-

ston were most advisable. Iron, in whatever form we can best apply it, is the medicine which in such cases a judicious physician would have recourse to. In the waters of Ballston, we have found it in sufficient quantity to show strong chalybeate qualities. But if there are any one class of patients more than another who require to be cautioned in the use of mineral waters, it is perhaps those of the female sex whom I am now addressing. I have seen too many instances of the injury arising to such young persons in particular, from the incautious use of purgative mineral waters, not to guard them against it. That which may be a valuable remedy if taken with judgment and moderation, becomes seriously injurious if taken incautiously. In order, therefore, to render those waters efficacious in such diseases as I have described, the first circumstance to be attended to is, that the patient selects that well which contains the most iron, and the least salt, lest the purgative effect of these salts may counteract the tonic effect of the iron, and increase that debility which it is intended to remove. Ballston water therefore, in cases of debility and relaxation of the system, should generally be preferred to the Congress Spring; but if it should be found that the astringent qualities of the one should require the occasional use of a purgative, recourse may sometimes be had to the more saline waters.

It should never be forgot that in commencing a course of these waters, the patient should begin with

small quantities; one or two half pint glasses are fully sufficient before breakfast, and the same quantity may be repeated in the middle of the day, particularly if the purgative effect of them is not intended or wished for. It is from the iron, the carbonic acid gas, and perhaps from the stimulating effect of the small quantity of common salt which these waters contain, that the whole benefit of them may be expected; and as in all cases of the uses of steel, more benefit arises from the length of time which it is persevered in than from the quantity taken at any one period, it will be necessary that the use of this water should be regularly persevered in for a month or six weeks; without attention to this, little permanent benefit can be expected in any chronic case of this nature. However, on this subject I have already given my opinion very fully.

There is a proneness to inactivity in the complaint which I here treat of, which requires particular exertion to counteract. Without attention to exercise, particularly on horseback, those waters, or indeed any other, will be less effectual. The occasional use of the warm bath will also be found highly beneficial during a course of these waters. A light but generous diet may be allowed; and as whatever promotes the animal spirits will have great influence in the cure of such diseases as these, such persons should endeavor to employ their time in cheerful and agreeable amusements, indulging moderately in the sprightly dance, and guarding against all sources of uneasiness

or anxiety of mind, the too frequent cause of such diseases in females of refined sensibility.

Among other diseases which are greatly relieved by the use of these waters, I may mention the hemorrhois or piles. One of the principal symptoms in this complaint, and indeed one of the exciting causes of it, is a tendency to costiveness, which produces some of the most distressing symptoms. The disease itself, though a most disagreeable one, is by no means a dangerous one; and when it has remained so long as to become habitual, perhaps it should not be suddenly suppressed. It sometimes arises from plethora or fulness of the vessels, attended with great pain and inflammation; at other times it is produced by debility, or relaxation of the vessels. These two cases require different modes of treatment. In the first case, where there is a plethora in the system, and where the hemorrhois are attended with pain and inflammation, it would be highly expedient before commencing a course of those waters, to open the bowels with some more certain and effectual purgative than any of them; when the action of the bowels is thus excited, it may be regularly kept up by a daily use of the waters of the Congress Spring, without exciting any irritation or producing excessive debility. But as there are also cases where the hemorrhois have been caused originally by relaxation, or where this relaxation and debility has been produced by a long continuance of the disease, and from an excessive discharge from the hemorrhoidal vessels, a mode

of treatment somewhat different should be pursued. While costiveness should diligently and carefully be guarded against, recourse may be had to the Ballston water, as being more tonic and less purgative. The utmost attention should also be paid to diet and regimen. The food should be as light as possible; the patient should sleep cool, and on a mattrass; moderate exercise on foot or in a carriage may be allowed, but that of a more violent kind should be avoided.

Among the diseases with which the human body is afflicted, perhaps there are few more dangerous and troublesome than worms. There are a great variety of them with which the system is affected; and it unfortunately happens that it is not always easy to distinguish the symptoms which characterize this disease, as many of those complaints which children in particular are subject to, are attributed too often to worms which do not exist. Nothing can really decide the nature of the complaint, but the proof that worms have been discharged. However, as the symptoms which generally accompany this complaint are decisive evidence of a foulness in the stomach and bowels, attended with a preternatural discharge of mucus and slimy matter, and as relaxation and debility is the natural consequence of such a state of the bowels, it will readily occur to those who have any knowledge of these waters, that they may be used by persons affected with symptoms of worms with the most decided advantage. The waters

of Harrogate have been celebrated in the cure of such complaints; and Dr. Alexander, whose authority as a physician must have great weight, observes that these waters "are the most sovereign remedies yet discovered." A reference to the synoptical table will show how far these waters resemble those which I treat of. With respect to their most essential qualities, they must be allowed to be inferior to those either of Ballston or Saratoga, unless the sulphur with which they are impregnated gives them any peculiar advantage, nor am I disposed to deny that it may have some specific effect in the removal of worms; however, I am satisfied that there are very few cases indeed in which the waters of Saratoga will not procure effectual relief; and as the Congress Spring contains more of the muriat of soda than any of the rest, this should be always preferred; but previous to the use of it, I would recommend one or two doses of rhubarb and calomel according to the age of the patient, after which the water may be drank in sufficient quantity to keep up a regular discharge from the bowels, till the whole of the worms are discharged, after which the waters of Ballston may be used with more advantage to restore the tone of the system, recollecting that in this as in all such cases, a cure cannot be expected in one of those short visits which are generally made to this place.

I should not omit remarking, that there is one species of worm called the ascarides, with which

children in particular are affected; it is generally seated in the rectum, producing the most distressing symptoms. Besides the internal use of those waters in sufficient quantity to act as a purgative, great benefit may occasionally be obtained in such a case by injections of the Saratoga water thrown up into the intestines. This practice is very much recommended at Harrogate, and is frequently attended with the most effectual relief.

Attention to diet is as necessary here, and perhaps more so, than in most other complaints; and as it is one of the most prevailing diseases of children, and is oftener than is suspected brought on by improper diet, parents cannot be too cautious in guarding against such imprudence, as well as the too common indulgence of permitting their children to follow the guidance of their own appetites.

Those who are suspected of worms, should abstain from all crude vegetables and unripe fruits, and more particularly guard against that prevailing taste for cucumbers, melons, &c. which, except in very particular circumstances, are never to be allowed. The diet should be easy of digestion, and should consist chiefly of wholesome bread and animal food that is light and nutritive.

Among a variety of diseases for which these waters have been long celebrated, may be mentioned eruptions of the skin. It is with me, however, a matter of some doubt, whether they are so generally useful as has been supposed. Though this is a disease which

can scarcely be mistaken in appearance, yet it is often confounded with those of a scorbutic kind, to which it has very little resemblance. Herpes of every description, as Dr. Garnett observes, generally attacks the young and plethoric, who, in other respects, enjoy high health: and it is in its nature almost always inflammatory. The scurvy, on the contrary, shows every indication of a putrid state; and when it is not brought on by putrescent diet or long abstinence from fresh vegetables, it is mostly confined to the weak and debilitated valetudinarian.

As these two diseases have no connexion, I shall confine what I have to say on this subject to those cutaneous complaints of the herpetic kind for which these waters may be often used with advantage.

There are three or four species of herpes, as described by medical writers; differing, however, but very little from each other, except in the extent and virulence of the eruption; and requiring nearly the same mode of treatment.

This disease commonly appears on the face, though no part of the body is exempt from it: the legs, the arms, the limbs, and even the surface of the body, is often covered with it. The two principal varieties of it are the dry and scaly herpes, and the herpes pustulosus or miliaris, which generally appears in the form of an infinite number of small pimples containing a clear lymph, which exudes from them and produces great pain, itching, and irritation.

Persons attacked with these complaints find their general health but seldom affected, it being a local disease and confined to the skin. Indeed, the greater number of those who are subject to such complaints enjoy excellent health, and are perfectly free from any constitutional disease.

The general cause assigned for these complaints of the skin, are exposure to cold when the surface of the body is heated; by which perspiration is obstructed, and that proportion of saline matter which ought to pass off by the skin, is not evacuated, but is accumulated under the cuticle where it produces itching, redness, and inflammation; and subsequently an eruption on the part.

Thus we see the reason why those whose constitutions are the most robust, and who have indulged freely in the luxuries of the table, are more frequently affected with it than others; particularly if they expose themselves to cold air after a full meal, and when the vessels are in a high state of excitement.

Whatever may be the real cause of all those complaints of the skin which we so frequently meet with, they are diseases of a most obstinate nature, most difficult of cure, and are apt to return from any exciting cause; such as irregularity in diet, or change of weather.

In slight cases, as they are purely of a topical nature, no internal remedies are necessary. Attention to cleanliness, washing the parts occasionally with

some astringent lotion, and the frequent use of the warm bath will be sufficient. But in inveterate cases of long standing, recourse must be had to internal as well as external remedies. As my business here, however, is merely to speak of the use of these waters, I shall refrain from entering into the numerous class of medicines which are usually prescribed in such complaints.

I have no doubt whatsoever but the waters of Ballston or Saratoga may be used with advantage in many cases of complaints of the skin; but not so indiscriminately as they generally are. Where the complaint is purely local, I have never seen the smallest advantage from the internal use of them; but in those constitutions where excitement has been produced in the system by excessive luxury and great indulgence in the pleasures of wine, eruptions are extremely common, particularly on the face, and may be frequently removed by a regular course of the waters of the Congress Spring, taken in such quantity as will promote a free and regular discharge from the bowels; and assisted by that regularity and abstemiousness in diet, which is so conducive to general health.

While at these springs, I have seen many cases of this kind relieved; but in none of a topical nature, have I ever known any thing more than mere temporary benefit; and even these cases were to be attributed more to the external use of the bath, than the internal use of the water. I was consulted by one

gentleman, who had been sent by his physicians from a great distance to drink these waters for an eruption on the face, which was originally purely of a topical nature, and brought on in an accidental manner; but who, after drinking the Ballston water for two months with the most commendable patience, without any advantage, was obliged to have recourse to those remedies of an external and internal nature which I prescribed for him; and which, with the use of the warm bath, he may have applied with the same benefit at home.

I do not pretend to say that a regular course of the Saratoga water will not greatly assist the cure in many instances; but I must observe, that there appears to me no actual advantage to be derived from it, except what arises from its purgative quality; nor do I see any great superiority which a bath of this water can have over a bath of any other, except it may be imagined that a warm bath, containing a certain proportion of common salt, is preferable to a simple bath of common water. Did this water contain sulphur in any form, such as those of Harrogate, Moffat, and Aix-la-Chapelle, I should think it very superior to any other, when used externally or internally, in almost any species of cutaneous complaint. Experience has proved the efficacy of such waters, and thus has classed sulphur as a sort of specific in the cure of herpetic eruptions.

However, as we have no knowledge of any such waters in this country as those of Harrogate or Aix-

la-Chapelle, we should not neglect to make use of those which have any similitude to them.

While on the subject of warm bathing, and particularly in cutaneous diseases, I cannot help remarking a peculiarity in the waters of Ballston and Saratoga, which has not been much noticed, but which requires some attention. From a reference to the description and analysis of these waters, it will be recollected that they contain a certain proportion of oxyd of iron and a very considerable quantity of alkaline earths, all of which are precipitated when the water is boiled for any time; after which, the water becomes turbid: all this may be easily observed by any person who visits the bath. I know of no valuable quality which these substances possess as ingredients in a warm bath; and all those who bathe in such water, feel extremely uncomfortable from the effect of these substances on the skin, and the difficulty of removing it. There is, however, a natural prejudice in favour of a bath composed of a mineral water which has any remarkable quality; and I should not be inclined entirely to reject it, in a variety of diseases requiring a stimulating effect on the surface of the body; such, perhaps, as palsy and chronic rheumatism, where no ill effects can arise from a hot bath of these waters. But in cutaneous diseases, it has always been considered a desideratum to select that water for a bath which is best calculated for cleansing the skin from the grosser parts of perspira-

ble matter which is always flying off, and to produce a salutary relaxation on the surface of the body.

Those waters, therefore, which are the purest, or contain the smallest quantity of earthy salts, have always been considered as the best calculated for this purpose; and wherever an excess of alkali prevails, they are preferred from the superior cleansing properties which they possess. Since this is the case, I cannot but think that in all eruptions of the skin, a bath of the purest and softest water should be preferred; but most particularly in that species called the *herpes farinosus*, or scaly eruption.

In the use of a bath in cutaneous complaints, a variety of circumstances of more consequence than is generally supposed, should be attended to. First, as to the regulation of the heat: the degree of it should be always determined by the thermometer. No person should ever do so by his own sense of feeling, or trust to that of the attendant, as nothing can be more fallacious; no two persons could ever agree in this mode of doing so, as the sensation produced is always in proportion to the degree of heat to which the body had been previously exposed.

In diseases of the skin, a tepid temperature of the bath is all that is required. At first this should not exceed ninety degrees: it may, after being a few minutes in the bath, be raised to one hundred; but this should also be regulated by the thermometer. With respect to the time of continuing in the bath, it should at first not exceed ten minutes; but it may

be gradually increased to twenty minutes, or even half an hour, longer than which the patient should never remain in it.

No enquiry is more frequently made than how often the bath should be used, and at what time of the day. In general those who are afflicted with cutaneous complaints, may go into it two or three times a week, or perhaps every second day. If it is intended to encourage and promote perspiration, the best time of using it is late in the evening; after which, he may go into bed, and take a little warm white wine whey, to which a few drops of antimonial wine may occasionally be added, avoiding the effect of cold air the next morning. Whenever the surface of the body will allow it, the use of a flesh brush or a flannel will be useful in removing the scurf from the skin and opening the perspirable pores on the surface.

The plan which is generally pursued at Harrogate, and is recommended by so competent a judge as my late inestimable friend and fellow student Dr. Garnett, is, that in drinking the waters during the use of the bath, it will be prudent to omit them on the morning after going into the bath; but to take them every other morning, and occasionally between breakfast and dinner, to the quantity of from three to four glasses, or sufficient to keep the bowels constantly open, as the disease is generally attended with a plethoric or inflammatory state of the system; gentle purging will tend to remove that disposition, and the

waters of the Congress Spring, if judiciously drank, are the best adapted for this purpose.

I have been more particular than perhaps may be thought necessary on this head; but finding that it is but little understood by invalids in general, I thought it might not be unacceptable to those who visit the springs to receive such information as I possessed on the subject.

Many who suffer extremely from complaints of the bladder and kidneys, usually called gravel, find great benefit from drinking those waters. Indeed, these are complaints in which they are decidedly useful. It cannot be pretended that they act as solvents of the stone, but they greatly relieve and mitigate all those complaints of the kidneys and bladder which are connected with the formation of calculus. Seltzer and Spa waters have been long celebrated in this complaint; and there can be no reason to doubt that the waters of Saratoga in particular have not the same good qualities. In most cases, they have apparent diuretic properties; and it is well known, that under a moderate use of them, the mucous, sabulous and often purulent discharge which accompanies the urine, is rendered much less painful, and in general micturation becomes less difficult. These benefits arise from the quantity of carbonic acid which the water contains, as well as from its saline contents, which contribute to keep the bowels moderately open. Its alkaline earths, when they are supersaturated with carbonic acid, appear to be useful in correcting

the acidity which prevails in the stomach, and their combination with this excess of acid, certainly renders them mild and inoffensive to the system; though *a priori* in this complaint in particular the contrary may be imagined.

Experience has fully demonstrated the salutary effects of a solution of alkaline salts, highly charged with carbonic acid, in all nephritic complaints; and analogy would lead us to conclude, that natural waters containing the same gas would possess the same properties; in addition to which, these waters contain such a proportion of a neutral salt, as cannot be without some advantage, particularly if there is the smallest tendency to inflammation in any of those organs which are the seat of the complaint, and which frequently arises from the passage of an irritating substance from the kidneys down the ureters. In any such case, in addition to the internal use of the water, recourse must be immediately had to the warm bath, which should be of a low temperature, to produce relaxation in the parts, and should be repeated on any recurrence of such symptoms.

But after all, these waters give but temporary relief; and they should be persisted in for a considerable time, in order to reap every advantage from them. Few persons are ever so happy as not to be subject to occasional returns of the complaint, which requires as much attention to diet and regimen as any other.

The diet of those who are afflicted with either the stone or gravel, should be light and nutritive.

No fermented liquors should be drank, and all wines which have any tendency to acidity, or which abound in tartar, should be also avoided.

Having thus at some length taken a view of those diseases in which the waters of Ballston and Saratoga are indicated, and suggested the most proper mode of using them, it now remains for me to point out those cases in which they may be highly injurious as well as those in which their effects may be of a doubtful nature. And first, let me caution all those who visit those springs against that dangerous delusion that such waters may be drank in any manner or in any quantity under every circumstance of health or disease, as if profuse purging, as Dr. Fothergill so well observes, "was a matter of indifference or rather necessary to improve good health," while every judicious practitioner is aware that the habitual use of purgatives, even of the milder sort, not only impoverishes the habit, but injures the constitution, laying the foundation of a variety of hypocondriacal and nervous affections.

The first complaint which I think it necessary to say a few words on, is apoplexy; and I am the more induced to do so, because I find the waters recommended, and I have known them used, for this disease; but such a practice is always attended with danger, and never should be advised except in very peculiar cases. The external signs of a predisposition to apoplexy, are a large head, short neck, a tendency to corpulency, and generally a red turgid counte-

nance. The symptoms preceding an attack of it, are, swimming in the head, giddiness, headache, false vision, &c. Now all these symptoms would be brought on by the use of these waters.

To prevent these attacks, nothing is more useful than evacuations by stool; but these should be brought on by medicines that have no stimulant qualities, such as iron and carbonic acid gas. The water of the Congress Spring even, will not affect every person as a cathartic without the assistance of some medicine, or drinking it in such a quantity as to overload and distend the stomach, which would be the most certain way of bringing on a fit of apoplexy wherever there was a predisposition to it. In preventing or warding off an attack of this complaint, every thing depends upon attention to diet, regimen, and exercise. If any mineral water can be of use, it is only one of those simple saline waters that possess strong cathartic powers, without any other ingredient, such as those of Epsom, and Sedlitz. As to the hot bath in this disease, it is scarcely necessary to observe, that owing to the rarefaction and distention of the vessels which it occasions, it is one of the most dangerous remedies.

The use of this water in epilepsy is of a more doubtful character; it has been asserted that persons subject to this complaint, have been relieved by the use of them; and as epilepsy arises from such a variety of causes, I cannot dispute it: for instance, one of the exciting causes of epilepsy, particularly in

children, is worms; if, therefore, a course of these waters remove those worms, the epileptic fits will soon disappear. But I have the authority of one of the most celebrated and judicious physicians in Philadelphia, to state, that he was consulted in a case of epilepsy which recurred once a fortnight, and for which the waters of Ballston were indiscreetly recommended. The consequence was, an immediate aggravation of the complaint, the paroxysms becoming so frequent as two or three times a day during the use of them. For myself, I confess I have no experience of the effect of them in epilepsy; but of so doubtful a nature do I consider them, that I should never recommend the use of them, except under the immediate care of a judicious physician on the spot.

Phthisis pulmonalis or consumption of the lungs, is another disease for which those waters have been recommended; but I greatly doubt the propriety of this practice. In the latter stage of the complaint, where the febrile symptoms run high and the pulse quick, they must be injurious. It may, however, be worth consideration whether in the first stage of the complaint, where there is a hereditary scrophulous taint, and a suspicion of tubercles beginning to form, this water, drank with great discretion, may not have some effect in retarding the progress towards suppuration. But where there is much cough and tightness in the chest, it is manifestly injurious.

In the early stages of the hooping cough, these waters are dangerous; but when the inflammatory

period is over, and the cough continues, the disease is then a disease of debility. The cough continues from habit, and is chiefly spasmodic; in this latter stage of the complaint, removal to a distance from home is often of benefit; and I have seen one instance, which was rather of an alarming nature, where the change to the air of Ballston, with a regular and discreet use of the water, proved a permanent cure.

I cannot agree with the generality of writers who recommend such waters as Ballston and Saratoga in cases of the gout, under any form of it, but more particularly in the atonic or retrocedent species of it; where there is a regular fit of it, they are evidently improper; and where it is unfixed and attended with cramps in several parts of the body, severe pain in the stomach, &c. the certain consequence of drinking a cold saline purgative at such a period would be to fix it in the more vital organs instead of the extremities. A case of this nature occurred to me while at Ballston, in a gentleman from the south, who consulted me after having drank the water of the Congress Spring for some weeks, with great aggravation of a complaint which he described as seated in his stomach and bowels, attended with a discharge of blood from the intestines. Having some suspicion of the cause, I asked him whether he was subject to the gout, to which he answered that he had been a martyr to it for many years, but that he had no regular fit of it for a long time, and was ordered to Ballston

by his physician. Thus the history of his complaint was explained; and after the most urgent symptoms were removed by proper medicines, he had nothing more to do than to refrain from the use of the waters, and to remove to some more eligible place. Here do we see the consequences of not understanding the nature and qualities of the water we prescribe, or even of those that are really beneficial in many complaints.

It is not my intention to discuss the different methods of cure in every complaint; my proper duty here is to point out only those instances where the waters of Ballston are beneficial, and where they are highly injurious. I shall, therefore, in this case barely remark, that of all places whatsoever, patients labouring under atonic gout should not be sent to Ballston; and that if there are any such mineral waters in these States as we find at Bath or Buxton in England, they should be preferred; as they differ both in temperature and in every other quality from such as I am describing; and long experience has proved that they are of essential advantage in atonic gout in particular. It has been intimated to me that springs of very high temperature have been found in the state of Virginia; if this is the case, it is more than probable that they have some qualities in common with the waters of Bath. It is, therefore, much to be regretted at present that we have no satisfactory description of waters possessing such valuable medicinal properties.

The waters of Ballston have been supposed useful in rheumatism; but upon what principle I am at a loss to determine. Neither from theory or practice should I be inclined to advise it. Most assuredly so far from being of service in that species of rheumatism styled the acute, it is highly improper; and there cannot be a stronger proof of the ignorance which prevails at a distance with respect to the qualities of these waters, than observing as we do a number of invalids at the springs crippled with this disease. I cannot say that I ever knew any benefit derived in such cases from the internal use of it; and if, as certainly is the case, some are relieved by the warm bath, there is no necessity of resorting to it at such a distance, when it is not endowed here with any peculiar qualities. I was consulted by a gentleman from Virginia, who had patiently drank these waters for many weeks without any benefit, but who was recommended to take such a journey to these springs by his physician at home; which was even the more remarkable, as so obvious and efficacious a remedy as the warm springs of his own state, should have been selected. These remarks apply equally to paralysis or palsy of any part of the body, a disease in which the waters either of Ballston or Saratoga are by no means calculated to be useful.

In cases of dropsy, I consider the use of these waters as of a very doubtful character; indeed so much so, that I should scarcely think it necessary

to mention it, had I not seen it recommended in the only publications which I have met on this subject. To rely in any degree on the use of these waters as a cure for dropsy, would, however, be extremely injudicious: still, after the water has been evacuated, and some progress towards a cure has been made by proper medicines, the use of these waters may have salutary effects in restoring the tone of the system, while the neutral salts which they contain will tend to stimulate the action of the kidneys.

Some question has arisen whether these waters are beneficial or not in diarrhœa, or dysentery. With respect to the first, I cannot see any indications for the use of it; and as to dysentery, which at its commencement is accompanied with severe febrile symptoms, I should not only think it a very doubtful, but a very dangerous remedy. However, in the latter period, when the fever has subsided and general debility is the attendant consequence, or in that stage which is usually called chronic dysentery, the waters of Ballston, taken with discretion and moderation, may, from their tonic qualities, prove occasionally useful.

There are, perhaps, a few other diseases in which the waters of Ballston and Saratoga may be occasionally taken with advantage; but I have already entered into a fuller detail of the medicinal qualities of these springs, than I originally intended. Those who take the trouble of perusing this work will perceive that I have treated the subject with the

utmost freedom and candour, avoiding all theoretical discussions or speculative observations. If in the course of my enquiry I have collected any new facts capable of leading to useful conclusions, or if from these facts I have drawn such practical results as may appear valuable to the medical profession or interesting to the invalid, I shall feel great satisfaction in the reflection that I have added a little to the general stock of knowledge.

FINIS.

APPENDIX.

ANALYSIS OF LEBANON SPRING,

STATE OF NEW-YORK.

SECTION I.

Description of Lebanon.

THE village of Lebanon is situated in the state of New-York, on the direct road from Albany to Boston, and about twenty-eight miles distance from the former place. It adjoins the states of Massachusetts and Connecticut, from each of which it is not more than three miles distant. The approach to this village is through a rich and fertile country, agreeably diversified with hill and dale. The spring is situated on the south side of an eminence, and at least one hundred and fifty feet above the level of a rivulet which runs in the valley beneath, and passes through the village. From the portico of the hotel, the eye has an extensive prospect of the surround-

ing country, exhibiting a landscape highly interesting from the beauty of its mountain scenery; the native roughness of which is agreeably relieved by a view of the Shakers village which opens at two miles distance, and exhibits all that luxuriance of cultivation and attention to neatness and order which characterize that industrious but singular class of people.

The soil in the neighbourhood is of a good quality and highly cultivated, particularly in the village. And wherever limestone is a predominant rock, as is here in many places the case, it is most sensibly distinguished by the luxuriance of the vegetation, and the superiority of the crops. At this side the Hudson river, as I have already remarked, the mineralogist soon perceives a transition country, the whole of the rocks in the neighbourhood of the spring being of this character; consisting of transition limestone, transition greenstone, gray wacke, and transition slate. Those rocks, as is usually the case, and particularly the transition limestone, form high mountain masses, cliffs, and precipices. Such rocks are said generally to contain organic remains, yet this is not always the case; and though I have examined the strata of this place with great attention, I have never been able to discover any trace of animal or vegetable impressions in them. The position of the strata is always found here somewhat inclined, distinguishing it very decidedly from the flœtz or horizontal formation.

In the neighbourhood of the spring in particular, the rocks which are most abundant are limestone and gray wacke; both of them have a slaty fracture. The limestone is of a dove colour, striped or veined; it has a very fine grain, and is almost compact, which is a sufficient distinction between it and primitive limestone; it is also frequently traversed by very small veins of white calcarious spar. The gray wacke is a very abundant rock in this neighbourhood; it is also fine grained and of a slaty texture. Superincumbent on this, lies a slate varying in colour from green to gray, and passing into talcose and chlorite slate. How far to the northward this transition range extends, following the course of the Hudson, I am not prepared to say; but after having crossed a very high range of hills which run nearly north and south, and proceeding to the eastward on the Boston road for about seven miles towards Pittsfield, the primitive formation again commences and continues to prevail with little interruption as far as the Penobscot river, which is the utmost extent that has been accurately examined.

SECTION II.

Situation of the Spring,—Temperature, Specific Gravity, and External Qualities.

The situation of the spring at Lebanon is the most agreeable possible, at a considerable elevation on the south side of a hill, commanding a delightful view of the surrounding country, and a most salubrious atmosphere. The water of this spring rises with great rapidity from the crevices of those schistose rocks which I have before described, where a well has been dug about five feet deep and seven or eight feet diameter. The temperature of the water is uniformly, through the whole year, 73° of Fahrenheit. No steam arises from it in the summer, but in the winter it is constantly covered with a dense vapour. Only one spring of this nature has ever been discovered, while the temperature of all others in its neighbourhood are as usual 52; and it is more singular that a very abundant one of this low temperature exists within twenty yards of the warm spring, and nearly on the same level with it. The supply of water from the thermal spring is so abundant, that it is calculated to discharge near ten hogsheads in a minute; and advantage has been taken of this and the elevation of the ground not only to supply all the baths, but to turn two or three mills which are erected within a short distance;

which mills, from the temperature of the water, have the advantage of being kept in action during the severity of the winter.

The sensible qualities of the waters of Lebanon are not very peculiar; it is as transparent as crystal when taken from the well, and continues to preserve this transparency after boiling or long standing; it does not sparkle or send out any air bubbles when taken up in a glass; it has no smell; its taste is neither brisk or acidulous, not unlike pure water but rather more vapid or insipid. A person who has just visited Ballston will be most particularly struck with the insipidity of this water, as perhaps no two waters differ so much as they do in almost every particular. Having examined the specific gravity of this water with distilled water raised to the same temperature, so little difference appeared that it was scarcely distinguishable; at the utmost it was only as 1002 to 1000. An innumerable number of air bubbles are constantly arising from the crevices of the rock at the bottom of the well; these ascend in a rapid manner through the water with considerable agitation, and seem all to break on the surface without being absorbed by the water in their passage.

SECTION III.

Examination of the Gaseous contents of the Spring.

THE first step towards an examination of the gaseous contents of this spring was to ascertain what was the nature of that gas which rises in such abundance with the water, and breaks on its surface. This gas, as far as I know, has never yet been examined. It was always supposed to be fixed air or carbonic acid; but the manner in which it arose and broke on the surface, so much more abundant and so different from the gas which arises from the well at Ballston or Saratoga, while at the same time the water of this well was totally free from any pungent or acidulous taste, led me to suspect that the greater part of it at least was not carbonic acid gas.

In order to ascertain the nature of this gas, I collected a sufficient quantity of it, by means of an inverted funnel, in a bottle graduated into cubic inches. This was immediately plunged into a vessel of fresh lime water, and let remain in it for some time, frequently agitating the bottle over the lime water; but I found that no diminution of the quantity of gas had taken place, or that no portion of the gas in the bottle had been absorbed. This gas, therefore, could not have been carbonic acid, and must have been azote or common air. To determine whether it contained azote, a lighted taper was

plunged into the bottle, but it was immediately extinguished. This proves that the greater part of it at least, if not the whole, was azotic gas; it is true a small quantity of it may have been common air, but it is not probable. However, in order to satisfy myself of this, I made use of the following very simple but accurate experiment, having no other more convenient eudiometer on the spot. I prepared a solution of hydro-sulphuret of lime, by boiling together sulphur and lime water; and as these substances, when fresh made, have the property of absorbing oxygen when combined with any other gas, I submitted this gas, which had been collected from the surface, to its action for some hours, frequently shaking it in a graduated bottle, but no diminution of its volume even now took place, which would have been the case had it contained atmospheric air.

The next point to ascertain was, whether the water contained any portion of this gas which had passed through it so freely, or whether it was impregnated with carbonic acid gas. For this purpose, I made use of the same instrument which I have described in the analysis of Ballston water, and which I found equally convenient here. This vessel was filled with one quart of water fresh from the well. Heat was applied, and in a short time an extrication of gas took place, but by no means with the same rapidity as in the Ballston water. This was received in a graduated bottle placed as described

over the mouth of the instrument; and when the whole had been collected, and the temperature of the gas reduced to sixty, I found that I had obtained only $10\frac{1}{2}$ cubic inches, this was then passed repeatedly through fresh lime water in a vessel, over which it was let stand for an hour; but I did not perceive that the smallest absorption had taken place, which perfectly satisfied me that this water was totally free from carbonic acid; but if any doubt could remain on the subject, it was decided by future experiments, to be related hereafter.

There could be no suspicion in this case of sulphurated hydrogen gas, which would have been very sensible by its smell. I had, therefore, every reason to believe, that the greater part if not the whole of those $10\frac{1}{2}$ cubic inches, was azote; and on examination with a lighted taper, I found that this was nearly the case, as the taper was extinguished; but not with the same rapidity as was the case when the gas which was taken from the surface of the well was submitted to the action of flame. I had reason, therefore, to suspect that a certain proportion of atmospheric air was combined with it. In order to determine this, I passed it up into a graduated bottle which contained hydro-sulphuret of lime newly made; and after having exposed it to this fluid for some time, I found that it had lost one cubic inch, or that the sulphuret had taken up one cubic inch of oxygen. If, therefore,

we recollect that atmospheric air contains nearly one fourth of oxygen and three fourths of azote, we may estimate, that out of $10\frac{1}{2}$ cubic inches which were collected from one quart of water, four cubic inches were atmospheric air, and the remainder $6\frac{1}{2}$ inches were azote.

As the nature of this gas is known to every chemical reader, I shall not intrude by describing it. The only circumstance worth consideration here, is how this or any other mineral water can absorb such a quantity of this gas, with which we cannot impregnate water in an artificial manner; or from whence or in what manner can such a quantity as is here extricated at the surface of the well, be produced. Dr. Garnett attempts to explain the manner in which it is combined with a mineral water, by stating, that as some simple substances cannot be united with water without being combined with others which assist the solution, so may this gas be rendered soluble by being combined with oxygen or atmospheric air, which we know water will absorb. But this, as he acknowledges himself, is not very satisfactory; for if so, why should we not also at the same time obtain oxygen or atmospheric air in greater quantity. It would, perhaps, be equally futile to attempt an explanation of the means from which such a quantity of azote is extricated. There is, however, one easy method of obtaining azote, which is by means of the decomposition of common or atmospheric air, and one simple process of

doing so, is, by exposing it to a mixture of iron filings and sulphur, or iron pyrites in a state of decomposition. Now if we suppose this process to be going on in the bowels of the earth, we may explain the manner in which a quantity of azote may be produced, as also account in some degree for the high temperature of the water, which would take place during this process. But speculations of this kind, unsupported by facts, serve only to amuse the reader. There is, however, something singular in the circumstance, that no carbonic gas could be obtained from this water; in every other instance that I can find, whether in a warm or a cold water, either carbonic acid gas or sulphurated hydrogen, or both, have been found in the same water combined with azote. This, according to Dr. Garnett, is the case at Harrogate, where all those gases have been found in the same water. In the same manner, according to Dr. Pearson, the water of Buxton, which is one nearly of the same temperature as Lebanon, contains both azote and carbonic acid gas. In none of them, however, has the same quantity of azote been found as I have described in the waters of Lebanon, which I now state as follows:

One quart or 57.750 cubic inches contains,

	Cubic Inches.
Atmospheric air - - -	4
Azotic gas - - - -	$6\frac{1}{2}$
	$10\frac{1}{2}$

SECTION IV.

Examination with Tests or Reagents.

Experiment I.

Litmus Paper is not changed in its colour when dipped into the water. This shows that no acid exists in it, not even carbonic acid gas in a disengaged state; as if it existed in any notable proportion, the colour would be changed to red, which would be fugacious.

Experiment II.

Lime Water, though added to this water in different proportions, was never altered by it. I know of no more accurate test than this of the presence of carbonic acid gas, as if the smallest quantity of it existed, it would be sufficient, when added in proper proportions, to create a cloud in the lime water. This experiment, therefore, fully corroborates the statement which I have already made, of the total absence of carbonic acid gas.

Experiment III.

Paper stained with Turmeric remains perfectly unchanged in colour when let stand in this water, which shows that no alkaline salt exists in it.

Experiment IV.

Prussiat of Potash produces no change whatso-

ever in the water, nor does *Tincture of Galls*, which shows the total absence of iron.

EXPERIMENT V.

Sulphuric Acid. When a few drops of this is poured into a glass of the water, not the smallest change takes place; nor is there any extrication of air bubbles in the glass, which would have been the case had the water contained any alkaline earths, or if carbonic acid, in any form, was present, as was so strikingly the case in the waters of Ballston.

EXPERIMENT VI.

Nitrat and Muriat of Barytes produce a white cloud when a few drops are added to a glass of the water, which, on standing for some hours, deposits a light white powder at the bottom of the glass. This shows the presence of a small quantity of sulphuric acid in a state of combination, most probably in the state of a selenite.

EXPERIMENT VII.

Nitrat of Silver. When a few drops of this solution are added to a glass of the water, a very sensible cloud is produced, and a trifling deposition takes place. This shows the presence of marine acid in a state of combination, but in very small quantity indeed; not so much as in any common spring in the neighbourhood.

Experiment VIII.

Oxalat of Ammonia, after a short time, produces a white cloud in the water, followed by a deposition of a white powder. This shows the presence of a small quantity of calcarious earth forming an oxalat of lime; and as the same appearance takes place when added to it after the water has been boiled for some time, it proves that this lime is in a state of combination, forming an earthy salt; most probably, as we have already discovered sulphuric acid, it thus forms a selenite.

Experiment IX.

Carbonat of Potash when poured into this water produces a milkiness, and after some time a white flocculent precipitate takes place. This test is an additional proof of the presence of an earthy salt, in small quantity.

Experiment X.

Solution of Soap in Alkohol. A few drops of this poured into a glass of the water produces a cloud in it. This is caused in the same manner as the former experiment; the alkali of the soap producing a slight decomposition of any earthy salt which is present, and which few of any waters are free from.

The above tests were sufficiently satisfactory to

explain what were the principal substances with which this water was impregnated. They appeared to be nothing more than selenite and some sort of muriat. Experience in such experiments, and in comparing the effects and appearances produced by different tests, had also convinced me that even those substances which I had discovered were in very small quantity. To ascertain this, I now proceeded to evaporation, the only true criterion of the exact proportion.

SECTION V.

Examination of the Solid Contents obtained by Evaporation.

The foregoing experiments with reagents having satisfied me that the water of this spring contained but a small quantity of foreign ingredients, I thought it necessary in proceeding to evaporation, to operate on a larger quantity of the fluid than I had done with the waters of Ballston. I accordingly placed two quarts of the water in a porcelain vessel, and commenced evaporation with a gentle heat, which never arose to the boiling point. As soon as the water was heated, minute bubbles of air appeared to collect round the sides of the vessel, but they gradually disappeared, still leaving the water perfectly clear and

transparent; no pellicle appeared on its surface at any time, nor did any deposition take place till nearly the whole was evaporated, when a light ash coloured powder began to deposit, and continued to increase till the process was finished, and the powder dried in a temperature of 160; it was then carefully collected and found to weigh only five grains.

These five grains were now digested for several hours in a small quantity of alkohol of as high a specific gravity as 827, filtered, and when dried in the same temperature it was found to have lost in weight only one grain. The few grains which were insoluble in alkohol, were afterwards submitted to the action of about eight times their weight of distilled water, the solution filtered, and the residuum collected on the filter and dried, was found to weigh only two grains and a quarter, so that the water had only taken up one and three quarters.

The first solution in alkohol, which only consisted of one grain, I now examined in the following manner: it was evaporated over a lamp in the bottom of a Florence flask till a small acrid gelatinous substance was obtained, which was heated to dryness. This was then converted into an aqueous solution by dissolving it in a small quantity of distilled water; and as it could be only muriat of lime or muriat of magnesia, from the result of former experiments, I examined it for the purpose of ascertaining this. To a part of it I added pure ammonia; but no change took place, which showed it did not contain mag-

nesia. To another part, I added a few drops of oxalat of ammonia, when an immediate precipitate took place, which showed that it was lime only; and having found by nitrat of silver that the acid was the marine, it was now ascertained that the alkoholic solution was muriat of lime; and that as it had only taken up one grain, the contents of two quarts of water may be stated as follows:

1 grain muriat of lime.

The solution in distilled water was next examined; it was slowly evaporated till an appearance of crystallization took place. From former experiments the presence of a small quantity both of a muriat and a sulphat had been ascertained; to determine whether this contained any sulphat, a small quantity of it was dissolved in a few drops of distilled water, to which was added a little muriat of barytes, but no change took place; the remainder was then examined by adding a few drops of sulphuric acid and applying heat, when the strong fumes of muriatic acid, which soon appeared, determined the presence of this acid. In this solution, we have therefore discovered marine salt or muriat of soda, consisting of $1\frac{3}{4}$ in two quarts of the water.

The residuum which had resisted the action both of alkohol and distilled water, and which amounted to $2\frac{1}{4}$, remained now to be examined. It has been already shown that this water contained both lime and sulphuric acid in a state of combination; there

was, therefore, every reason to presume, that this residuum consisted of one or both of these substances. In order to take up the sulphat of lime, I boiled the residuum for half an hour in something more than 500 times its weight of distilled water, filtered and dried what still continued insoluble, when I found it reduced in weight to $\frac{3}{4}$ of a grain. That which had been taken up by the boiling water was therefore undoubtedly sulphat of lime; and as it amounted to $1\frac{1}{2}$ grains, we may conclude that two quarts of the water of Lebanon spring contains $1\frac{1}{2}$ of sulphat of lime.

The residuum which now remained, consisted only of $\frac{3}{4}$ of a grain; on this was poured a little diluted muriatic acid, when the whole was immediately dissolved with a slight effervescence; and the solution, when examined with oxalat of ammonia, showed the presence of lime.

The whole of the analysis for all useful purposes was now completed, and the result I shall state as follows:

Two quarts of the water of Lebanon spring contain,

	Grains.
Muriat of lime	1
Muriat of soda	$1\frac{3}{4}$
Sulphat of lime	$1\frac{1}{2}$
Carbonat of lime	$\frac{3}{4}$
Total,	5

Of aëriform fluids in two quarts of water:

	Cubic Inches.
Azotic gas	13
Atmospheric air	8
	21

Before I proceed to give any opinion upon the medicinal qualities of this water, it may not be uninteresting to make a few observations on the comparative contents and general circumstances of such thermal waters as we are best acquainted with. We have several examples, particularly in England, of waters so extremely similar in temperature and chemical qualities, to the waters of Lebanon, that scarcely any difference can be traced between them by the most accurate analysis. Those are the waters of Buxton, Bristol, and Matlock, in England; and of Mallow, in the south of Ireland. The highest temperature of any of them is that of Buxton, which is 82°; the lowest, which is that of Matlock, is 66; so that in temperature they nearly agree. Bristol, which is one of the most celebrated of these waters, stands at 74°, Lebanon at 73.

The contents of all these waters are nearly the same, viz. a small quantity of muriat of soda, sulphat of lime, and carbonat of lime. Buxton water has been found also to contain azotic gas, and I strongly suspect that all the rest equally do so. I am confident that Matlock water does, as I have observed the gas ascending from the well in the same manner, and ascertained it to be azote.

In another respect there is a very striking coincidence, which is, that in all those places the water rises in great abundance, and from rocks of the same transition formation as at Lebanon.

SECTION VI.

Observations on the internal and external use of the Waters of Lebanon.

The inferences which will naturally be drawn from the above analysis, will lead us to conclude that the waters of Lebanon spring are of an extremely pure nature, perhaps as much so as any water flowing from the bowels of the earth which have been as yet examined. Scarcely any common spring water is so free from foreign matter as this; its sensible and physical properties differ also but little from good common water. We must, therefore, in treating of its medicinal virtues, attribute whatever it possesses principally to temperature, independent of those qualities which so very pure a water may be supposed to possess when taken into the system in any quantity; and though, as I have already stated, I am not inclined to attribute to mineral waters of any description any very exclusive properties which cannot be shown by chemical analysis, yet I am not willing to extend this opinion so far as not to acknowledge, that such waters as Lebanon, possessing a high temperature and but few foreign or active ingredients, may in certain cases afford great benefit to the invalid. We cannot altogether reject the opinion of the best medical writers on this subject, nor the experience of those who have received great relief from the use of such waters.

In treating of the medicinal qualities of the Lebanon water, and judging from its analogy to those of Bristol in England, no doubt can arise of its possessing equal virtues. Bristol has been celebrated for centuries, for the cure of consumption; and perhaps there is no watering place in any country which is so much frequented.

That many persons with a predisposition to this complaint have been effectually relieved, and that others actually labouring under it have had many of the symptoms alleviated, I shall not pretend to deny; but that any person with a confirmed phthisis has ever been cured by the use of it, has never been satisfactorily proved. This is a disease which, even more than the gout, has always been the opprobrium medicinæ. When once it has got firm hold, the physician can do little more than relieve the urgent symptoms. With this intention, many of those are sent to such watering places as Bristol or Lebanon; and where medicine will often bring no relief, such waters, though not a cure for consumption, alleviate some of the most harassing symptoms in this complaint. It is, as Dr. Saunders observes, "particularly efficacious in moderating the thirst, the dry burning heat of the hands and feet, the partial night sweats, and the symptoms that are peculiarly hectical." All these benefits arise principally from the extreme purity of the water as well as its temperature, rendering the use of it in considerable quantity perfectly safe as a mild diluent. Something also may be

attributed to change of air and climate. No part of this country enjoys a more temperate or salubrious atmosphere than Lebanon; nor is there any place where the advantage of exercise can be more freely enjoyed.

After having spoken of the use of Ballston water in the cure of dyspepsia, and highly recommended it as a most valuable remedy in the most obstinate cases, it may be thought singular that I should venture an opinion on the use of so different a water as Lebanon in a disease of this nature; but those who are acquainted with the variety of causes which give rise to this complaint, and the variety of anomalous symptoms which attend it, will not be surprised at this apparent contradiction.

In those cases of dyspepsia which are but slight, where there is no organic affection of the viscera, where there is only a defective digestion and derangement of the alimentary organs, arising from a life of high indulgence, the use of Lebanon water alone, persevered in for some time, will give considerable relief; but more particularly if those dyspeptic symptoms have any connexion with a gouty habit and proceed from retrocession; in such case this water is much more safe and salutary than either the Ballston or Saratoga water. Besides this, the greatest advantage may be received from the use of it as a bath at its natural temperature; but if necessary, this temperature may be raised; and from such a bath as this alone, such patients cannot fail of finding relief.

The immediate effects of these waters on the system are so little sensible, that it is not surprising that they should be considered by many as purely inert. It often happens, however, that where the stomach is foul and loaded with bilious or acrid matter, this water often purges pretty freely at first; but this operation ceases when the intestines are restored to their natural state. The most common effect of this water is as a diuretic; from this many who have been affected with complaints of the bladder and kidneys, have received benefit. It may be drank in considerable quantity without any inconvenience, particularly if it passes off freely by the kidneys, in which case it relieves many of those painful symptoms which attend what are called attacks of the gravel.

Those who are much affected with the gout are frequently subject to nephritic complaints; in such cases such a water as this is much safer and more efficacious than any chalybeate or cold saline water; indeed no judicious physician would venture to prescribe waters of such a nature in any stage of the gout. Such waters as Buxton or Bath derive their principal credit from the relief which persons labouring under retrocedent gout receive from them; and although the temperature of Lebanon spring is not quite so high as that of Buxton, yet it comes nearer to it than any other; and the experience of many invalids have confirmed the opinion of its useful qualities; and yet, notwithstanding what I

have said, I should consider myself as in some degree deceiving my readers, if I was understood as stating this water to be possessed of any strong powers on the system. Reason as well as analysis will show at once that this cannot be the case. How different indeed is it in every respect from the waters of Ballston and Saratoga, which are so powerful that much of the physician's business is to prevent the abuse of them, while the waters of Lebanon may be drank with freedom without any apprehension.

Whatever I have now to say on this subject shall be principally confined to the use of this water as a bath in certain diseases. The ancients esteemed warm bathing not only as a remedy in disease, but as one of their greatest luxuries. With many in this country it is not so much used as a wholesome and even a necessary luxury, as it is made use of by the advice of a physician for the cure of particular diseases.

It is, however, better understood in Europe; and in many parts of it, particularly the south, is still considered so conducive to health, that their baths are constructed in a superb manner, and with as much attention to convenience and luxury as any of the edifices which they inhabit.

The use of the warm bath is now considered very justly as indispensable in warm climates. It has long been common in the French West India islands; and their exemption from disease when compared with the British, is probably in some measure to be attributed to the frequent custom of warm bathing. So

far from its producing relaxation or debility, as many suppose, it was formerly considered as the solace of toil, and resorted to with a view to renovate vigour exhausted by exertion. I have already made some remarks on its use in diseases of the skin, much fewer cases of which should we meet with if more attention was shown to strict cleanliness of person, or if that matter which is thrown out by the exhalents and suffered to accumulate on the surface of the body, was more frequently removed by the use of the warm bath.

With regard to the use of the waters of Lebanon externally, I cannot consider them as any more than a bath of a very pure water, and of a very agreeable and steady temperature, scarcely capable of doing mischief in any complaint, and in some cases of a sufficient temperature to be useful; but wherever the highest temperature (and such I consider should seldom exceed 98°) becomes necessary, it can be obtained here in as comfortable a manner as at any other watering place in this country, with the advantage of a plentiful supply of the same water.

As the natural temperature of the water is only from 73 to 74, it may be considered rather as a low state of a tepid bath. A slight shock is felt on first immersion, but much of this depends on the relative heat of the body at the time; but this is almost immediately succeeded by a highly pleasurable glow over the whole body, which persons describe as if the skin was anointed with some soft substance

with which the water was impregnated, but which entirely arises from its purity combined with moisture and temperature. On account of the slight effect of the shock, persons of a very delicate constitution can bear it without any disagreeable effect, as less reaction of the system is required to overcome it.

Such being the effect of this water, it will not be difficult to understand in what diseases it may be used externally with advantage. The greater number of cases which are most relieved by the use of this natural bath, are those in which particular parts of the body have suffered a loss of sensation or action, or where a certain degree of rigidity has seized any of the joints or limbs. When this arises from rheumatism of the chronic kind after the inflammatory action is over, much relief may be expected from the use of this bath even without additional heat. It may be remarked also, that it has one advantage, which is, that from the size of the bath and the quantity of the water, the patient may make use of any posture, or even move about during the use of it, a circumstance of no small advantage.

There are very few instances where invalids just recovering from the effects of long confinement from rheumatic attacks, can venture at once to plunge into a cold bath, however advisable it may afterwards be. The temperature of the Lebanon bath is in these cases a most admirable preparation for cold or sea bathing, as when a certain degree of healthy action is restored, a colder water may then be

used with greater advantage. There are also cases of gout where this bath may be used in its natural state, but in general it will be much safer to begin with it heated to a higher temperature. The true paralysis also requires a bath of a much more decided stimulus of heat than this water in its natural state.

In chorea sancti viti, considerable benefit may be received from the external use of this bath; and in many cases of cramps or spasms of any particular limb, experience has shown the good effects of it. Few such cases have come within my own particular observation while there, but I cannot entirely discredit the accounts which I have received of very singular cures which have been performed by the external use of this tepid water in complaints of this nature.

It would be only repeating much of what I have already said on cutaneous complaints when treating of the waters of Ballston, was I to enter into the particular nature of warm bathing in all herpetic eruptions; but as I consider the principal advantage of it to arise from moisture and temperature more than any peculiar substance which the water contains, (except, perhaps, in the single instance of a sulphurous impregnation,) I am inclined to the opinion that in almost all complaints of the skin, the purer the water the more effectual the bath. If this is the case, the water of Lebanon as an external remedy is at least as effectual as any other of the same temperature, whether natural or artificial; and it cannot be denied

that a bath of such purity is more agreeable and luxurious, than one which holds in solution a variety of extraneous substances.

With respect to the time of making use of this bath, it must be principally regulated by the effect which is intended to be produced. If the temperature is to be raised for the purpose of producing a diaphoresis, the best time is certainly late in the evening; but in no case should it be used after a full meal; and if it is used of the natural heat, the best time is certainly about an hour or two before dinner; seldom remaining in it more than ten minutes, and using a little gentle exercise after coming out of it.

THE END.